ENGINEERING ANALYSIS

FACILITY HISTORY

Sklar Exploration Company, LLC (Sklar) operates Oil & Gas Production Area No. 6 (Area 6) under SMOP Nos. 502-0103-X001 and 502-0103-X002 in northern Escambia County, south of Castleberry, AL in Sections 13 & 24, Township 3 North, Range 10 East. Area 6 is currently comprised of 3 oil & gas wells: CCL&T 13-11 #1 well, CCL&T 13-15 #1 well (formerly CCL&T 13-16 #1), and CCL&T 24-1 #1; one 203 HP Caterpillar G3306B engine (for gas lift), two 163 HP Waukesha F1197 engines (for power oil lift), one 145 HP Caterpillar G3306B/NA engine (for power generation), and two 68 HP Arrow VRG330 engines (also for power generation) are permitted for use within Area 6.

PROJECT DESCRIPTION

On 5/3/17, the Department received a new application from Sklar requesting to add two additional well sites—each with tanks, flare, heater, and two engines—to Area 6. The wells would be the CCL&T 18-13 and tentatively the CCL&T 14-9. The mineral rights for both lie within quarter-sections adjacent to those of the established wells in Area 6.

Each well would operate with one 163 HP Waukesha F1197 power oil pump engine for artificial lift and and one 68 HP Arrow VRG330 generator engine. Sklar estimates 150 bbl/day of oil and 300 Mscf/day of gas production from each. The average heat value of the gas at the three established wells is 1462.1 Btu/scf (at 14.65 psia and 60 °F) based on recent test reports submitted in the application.

The engines throughout Area 6 are numerous, and for organizational purposes will be referred to as follows in this analysis and in future permits:

Well	Lift Engine	New Name	Generator Engine	New Name
CCL&T 24-1 #1	163 HP Waukesha	LIFT-1	68 HP Arrow	GEN-1
CCL&T 13-11 #1	203 HP Caterpillar	LIFT-2	68 HP Arrow	GEN-2
CCL&T 13-15 #1	163 HP Waukesha	LIFT-3	145 HP Caterpillar	GEN-3
CCL&T 18-13 #1	163 HP Waukesha	LIFT-4	68 HP Arrow	GEN-4
CCL&T 14-9 #1	163 HP Waukesha	LIFT-5	68 HP Arrow	GEN-5

Table 1 – Engine listing

PROCESS DESCRIPTION

At each well site, the crude oil and produced water streams exiting out of the heater treater flows on to the power oil tank and salt water tank. Natural gas from the separators is routed to the pipeline when possible and the well-site flare when not. Flash vapor from the power oil tank and breathing and working losses from all the storage tanks is collected and sent to the flare for combustion. The flare at the well uses produced gas as pilot gas. The wells in Area 6 all reflect this general setup.

At the 13-11 well, LIFT-2 drives a compressor which provides artificial lift (which improves yield) by injecting gas into the well to increase the flow of the produced wellstream; GEN-2 drives a generator to provide power for the site. At the 24-1 well, LIFT-1 drives a power oil pump used to recirculate crude from the power oil tank back into the well to provide artificial lift, while its GEN-1 drives a generator to provide power for the site. At the 13-15 well (site of the dry 13-16 well), LIFT-3 will also drive a power oil pump when constructed, while GEN-3 will drive a generator for the site (Sklar requested a larger generator at the 13-15 site in case they expand operations in the area in the future, possibly placing the processing equipment for a new well on the same surface location of the 13-15 well). The 18-13 and 14-9 wells will have engine setups mirroring the 24-1 well with the engines designated LIFT-4, GEN-4, LIFT-5, and GEN-5.

PROCESS EMISSIONS

The potential emission sources for the facility currently include separators, tanks, and engines at the three established well sites. The increase in potential emissions from this project would come from similar equipment at the two additional well sites.

Heater emissions are determined using EPA's AP-42 factors. Emissions from the separators and tanks at each site are controlled by flares; potential to emit (PTE) for the flares is determined by AP-42 factors and mass balance based upon continuously burning gas at rates reported in the 2015 engineering analysis for SMOP No. 502-0103-X001 for the three established wells and 300 MMscf/day for the two proposed wells. The gas qualities for both the three established wells and the two proposed wells are from the gas analyses in Sklar's new application for this project. The Department calculates flare PTE from oil & gas wellsites as if all produced gas gets flared while oil production continues, though in ideal & typical practice Sklar sells both its gas and its oil.

Potential to emit (PTE) for the currently permitted LIFT-2 and GEN-3 were calculated as if the engines would operate at the limits imposed on them by 40 CFR Part 60 Subpart JJJJ. Those limits are: 1.0 g(NO_X)/HP-hr, 2.0 g(CO)/HP-hr, and 0.7 g(VOC)/HP-hr. These engine are controlled by EMIT Technologies non-selective catalytic reduction devices (catalytic converters) capable of meeting those limits. LIFT-1 is subject to Subpart JJJJ's reconstructed engine limits of 3.0 g(NO_X)/HP-hr, 4.0 g(CO)/HP-hr, and 1.0 g(VOC)/HP-hr, and its PTE is calculated as if it met those limits (though its catalytic converter is rated for better). GEN-1, GEN-2, & LIFT-3 are uncontrolled, and their calculated PTE reflects that.

Sklar has not ordered the individual engines that will be put into use at the 18-13 and 14-9 wells, but they have asserted in their application that they will be two 163 Waukesha F1197 HP power oil pump engines (LIFT-4 & LIFT-5) and two 68 HP Arrow VRG330 generator engines (GEN-4 & GEN-5), each constructed prior to 2006 and not subject to Subpart JJJJ. They have indicated their intent to operate all engines with EMIT Technologies NSCR devices regardless of not being subject to Subpart JJJJ.

For all engines with a catalytic converter, the estimated uncontrolled VOC emissions are lower than the maximum VOC emissions guaranteed by EMIT Technologies. This is because the engines are burning natural gas instead of LPG fuel, while EMIT Technologies' catalytic converters are designed to abide by the Subpart JJJJ standards of NO_X, CO, and VOC emissions at less than 1.0, 2.0, and 0.7 g/HP-hr respectively (standards which are shared by both natural gas and lean-burn LPG engines). Due to the nature of NSCR control devices, the VOC from the exhaust of natural gas engines will be controlled by those catalytic converters, but EMIT Technologies have just not quantified how much they will control below the 0.7 g/HP-hr level. This analysis will thus use the lower, "uncontrolled" VOC emission factors reported by Caterpillar and Waukesha, though the true PTE for VOC from these engines will be lower. The VOC factor from Waukesha is further inflated because it is reported as non-methane hydrocarbons (ethane + VOC).

Table 2 below shows the potential emissions of the facility after only accounting for required controls on the separators & tanks (flares) and engines subject to Subpart JJJJ limits (catalytic converters), drawing from data from past applications and analyses for the existing emission sources.

	Pollutant	Heaters	Flares	Engines	Total Emissions
Criteria Pollutant Emissions (TPY)	PM	0.11	0.78	0.42	1.31
	SO_2	0.01	0.30	0.05	0.36
	NO_X	1.66	29.82	106.66	138.14
	CO	1.17	162.24	128.54	291.95
	VOC	0.08	172.25	6.98	179.31
	Total HAPs	0.03	18.17	1.97	20.17
GHG Emissions (TPY)	CO_2	1,766.54	56,158.83	5,213.78	63,139.15
	N_2O	0.01	0.10	0.01	0.12
	CH_4	0.06	160.85	3.67	164.58
	Mass Sum	1,766.61	56,319.78	5,217.46	63,303.85
	CO_{2e}	1,770.67	60,208.97	5,308.58	67,288.21

Table 2 – Facility Potential Emissions after required control devices

Area 6 is subject to facility-wide SMOP limits of 95 TPY for CO. When writing the initial permit (X001), to allow for growth the Department did not require Sklar to adhere to a flare-specific CO limit derived by taking 95 TPY CO and subtracting the Engine and Heater PTE values calculated at the time. The actual flare emissions from the 12 months prior to January 1, 2017 were given in the semi-annual report as 6.002 Tons CO, which illustrates the capability of the facility to meet its current SMOP limits of 95 TPY for CO facility-wide without the need for a flare-specific limit even if the number of flares in operation were increased with the operation of 13-15 well and the addition of 18-13 and 14-9 wells. In practice, Sklar only flares when there are pipeline or other process problems disrupting the transfer of gas to the nearby gas plant, or if the well's production is too low to produce gas with adequate pressure to be transported through the pipeline.

Sklar has indicated their intention use NSCR converters on LIFT-3 when installed and on each engine at the 18-13 and 14-9 wells when permitted, though Subpart JJJJ standards that would necessitate that do not apply to that engine. Without using catalytic converters for those engines not subject to JJJJ, the total engine potential emissions are ~128.54 TPY CO and ~106.66 TPY NO_X, plus ~1.17 TPY CO and ~1.66 TPY CO from the heaters, exceeding the 100 TPY SMOP threshold for each without considering the emissions from Sklar's flares (which are more flexible).

EMISSIONS LIMITS

SMOP Nos. 502-0103-X001 & -X002 have a facility-wide 95 TPY limit on CO because when the SMOP was issued, CO was the only criteria pollutant with a calculated PTE of greater than the 100 TPY for major sources. At the time, the second-closest criteria pollutant to the 100 TPY threshold was VOC with ~78 TPY; VOC now exceeds the 100 TPY threshold after considering the new units in this proposal. Therefore, Sklar has requested a 95 TPY SMOP limit for VOC with the addition of these two wells. The flares at Area 6 have the potential to emit greater than 10 TPY of n-hexane (a HAP) based on the information provided in their application, which would exceed the 10 TPY major source threshold for any single species of HAP; they would not exceed the major-source threshold of 25 TPY multi-species HAPs. However, based on data provided to me, if facility's VOC emissions were limited to 95 TPY and if 7 TPY of that VOC were from the engines, Area 6 would always remain under 10 TPY of n-hexane emissions. Therefore the facility-wide SMOP limit for VOC effectively also functions as a SMOP limit for n-hexane.

There are unit-specific limits on LIFT-2, LIFT-1, and GEN-3 proscribed by NSPS Subpart JJJJ (reconstructed limits for GEN-3). Table 3 below shows the Subpart JJJJ standard in question for engines of this power.

	JJJJ Emission Standards					
	g/HP-hr			ppmvd at 15% O_2		
	NO_x	CO	VOC	NO_x	CO	VOC
New	1.0	2.0	0.7	82	270	60
Reconstructed	3.0	4.0	1.0	250	540	86

Table 3 – Subpart JJJJ Engine Emission Standards

Neither the LIFT-3 nor any of the proposed engines at the new wells will be subject to NSPS Subpart JJJJ based on their construction dates. Because the facility cannot operate under 100 TPY CO and NO_X if these engines were to be uncontrolled and because the Department cannot account for the control devices Sklar has volunteered to use without a limit and/or permit provision when evaluating PTE, Sklar has proposed that they will operate LIFT-3, LIFT-4, LIFT-5, GEN-4, & GEN-5 with the EMIT Technologies catalytic converters specified in the application. Sklar will show continuous compliance by calculating its total emissions every month, and to do so Sklar will test its engines to determine emission factors to be used in those calculations.

REGULATIONS

STATE REGULATIONS

ADEM Administrative Code Rule 335-3-4-.01(1)(a and b), "Visible Emission"

ADEM 335-3-4-.01(a) states that no person shall emit to the atmosphere an opacity of greater than twenty percent (20%) over a six (6) minute period. **ADEM 335-3-4-.01(b)** states that during one six minute period in any sixty minute period a person may discharge into the atmosphere from any source of emissions, particulate of an opacity not greater than that designated as forty percent (40%) opacity. Therefore, the units would be subject to this regulation. Since natural gas, or propane as a back-up, would be burned in those units, opacity should be negligible; however, if visible emissions are observed, the opacity should be determined using Method 9 of 40 CFR Part 60 Appendix A.

ADEM Administrative Code Rule 335-3-5-.01(b), "Fuel Combustion"

This regulation covers fuel combustion sulfur limitations for Category II counties, which includes Escambia County. This regulation requires that fuel combustion source in Category II counties limit sulfur compounds to less than 4.0 lb/MMBtu. The fuel-burning units burn propane and raw natural gas (with no appreciable H_2S) and accordingly have negligible SO_2 emissions.

ADEM Administrative Code, Rule 335-3-14-.04, *"Prevention of Significant Deterioration (PSD) Permitting"*

Based on the emissions found in Tables 2, the facility could exceed 250 tons per year (TPY) major source threshold for criteria pollutants for this type of facility (oil & gas production facilities are not one of the 28 source categories listed in this regulation) for CO. However, the facility currently operates and will continue to operate under a 95 TPY limit on CO, which is far more stringent than an anti-PSD limit such as 249 TPY CO. Greenhouse Gas (GHG) Regulations require a facility to address PSD regulations for Greenhouse Gases. Greenhouse Gases of concern for these sources would be CO_2, N_2O, and CH_4. Per Rule 335-3-14-.04(2)(a)1.(i)&(ii), no PSD review would be necessary for this project.

ADEM Admin. Rule 335-3-14-.06, "Determinations for Major Sources in Accordance with Clean Air Act Section 112(g)"

This regulation applies to major sources of hazardous air pollutants (HAPs) constructed after March 27, 1998. Since the addition the new units would not make this facility a major source of HAPs, a 112(g) case by case MACT review would not be necessary.

ADEM Administrative Code, Rules 335-3-15, "Synthetic Minor Operating Permits (SMOPs)" and 335-3-16, "Major Source Operating Permits (MSOPs)"

The combined PTE of the wells exceed the 100 TPY major source threshold for CO, NO_X, & VOC., and the facility also is also presumed to have the potential to emit greater than 10 TPY or more of a single HAP (n-hexane) as shown in Table 2. However, because Sklar accepted a 95 TPY limit on CO, NO_X, & VOC and because that 95 TPY limit on VOC essentially functions as a <10 TPY limit on n-hexane, the facility operates as a synthetic minor for both criteria pollutants and HAPs. Additionally, Sklar has adopted unit-specific SMOP limits on several engines to meet their facility-wide SMOP limits for NO_X and CO; namely, Sklar will operate catalytic converters on LIFT-3, LIFT-4, LIFT-5, GEN-4, & GEN-5 and will test each combination of engine model and control device models among those every 5 years for NO_X and CO emission factors.

FEDERAL REGULATIONS

40 CFR Part 60 Subpart A, "General Provisions"

This subpart is applicable given that facility is subject to one of the applicable subparts found under 40 CFR Part 60.

40 CFR Part 60 Subpart JJJJ, "Standards of Performance for Stationary Spark Ignition Internal Combustion Engines"

This subpart is applicable to stationary spark ignition internal combustion engines as specified in §60.4230(a)(1)-(6). LIFT-2 and GEN-3 were manufactured in after 2011, meaning the provisions of §60.4233(e) and the applicable standards of Table 1 of that Subpart are applicable to those engines. LIFT-1, which the Department approved operation of on 5/12/17, was manufactured in 1974 and was reported to be reconstructed after June 12, 2006. It is subject to the standards for reconstructed stationary natural gas engines above 100 HP [§60.4233(f)(4)].

GEN-1, GEN- 2, LIFT-3, LIFT-4, GEN-4, LIFT-5, & GEN-5 were all manufactured in prior to 2006 according to their applications, meaning only the provisions of §60.4236 are applicable to those engines [§60.4230(a)(6)]. However, because that engines have not been reported to be modified or reconstructed since June 12, 2006, those listed engines are not subject to this subpart.

	JJJJ Emission Standards					
	g/HP-hr			**ppmvd at 15% O_2**		
	NO_x	**CO**	**VOC**	**NO_x**	**CO**	**VOC**
New	1.0	2.0	0.7	82	270	60
Reconstructed	3.0	4.0	1.0	250	540	86

Table 3– Subpart JJJJ Engine Emission Standards

40 CFR Part 60 Subpart OOOOa, "Standards of Performance for Crude Oil and Natural Gas Facilities For Which Construction, Modification or Reconstruction Commenced After September 18, 2015"

This regulation was promulgated by EPA contains SO_2 and VOC requirements for natural gas production wells and natural gas processing plants constructed, reconstructed, or modified after September 18, 2015. The following table summarizes the portions of this regulation that apply specifically to well sites as affected facilities under this regulation:

AFFECTED SOURCES	APPLICABILITY
Each well [§60.5365(a)]	This applies to a single gas or oil well that is hydraulically fractured or re-fractured
Pneumatic Controller [§60.5365(d)(1) and (2)]	This applies to a single continuous-bleed natural-gas-driven pneumatic controllers with a bleed rate of > 6 scf/hr at an oil or natural gas production segment
Storage Vessels [§60.5365(e)]	This applies to a single storage vessels located in the oil and natural gas production segment, natural gas processing segment or natural gas transmission and storage segment that has potential VOC emissions > 6 TPY
Hydraulically Fractured Gas Wells [§60.5365(i)]	This applies to the collection of fugitive emissions components at a well site

Single Well

The 18-13 and 14-9 wells would not be affected sources under this subpart since they will be neither hydraulically fractured nor refractured, being in the Smackover layer.

Pneumatic Controller

Sklar has not indicated that they intend to construct any continuous-bleed gas-driven controllers at the 18-13 and 14-9 wells; therefore, the Department does not expect pneumatic controller affected sources as defined by this subpart to be present.

Storage Vessels

The storage vessels at the 18-13 and 14-9 wells will be constructed after September 18, 2015; the power oil tanks would be considered a Group 2 storage vessel under this subpart based on its uncontrolled emissions. At the wells, tank vapor is routed to a flare for combustion. §60.5365a(e) however only applies to tanks with an uncontrolled PTE of greater than 6 TPY of VOCs, and the determination of PTE "may take into account requirements under a legally and practically enforceable limit in an operating permit or other requirement established under a Federal, State, local or tribal authority". Because the permit includes a stipulation that Sklar may not emit gas without combustion, the closed-vent systems and flares should be included in the PTE determination of potentially subject tanks. Post-control device, the VOC emissions from all tanks are <6 TPY, and the tanks do not meet the definition of *storage vessels* under Subpart OOOOa.

Fugitive Emissions Components at a Well Site

Fugitive emissions components at the 18-13 and 14-9 wells applicable to this regulation will include the pumps, pressure relief devices, valves, connectors, and other required devices/systems (except compressors) in capable of leaking methane or VOC. As outlined in §60.5397a(a), the aforementioned equipment are subject to the leak standards in §60.5397a(b)-(g), the reporting requirements of §60.5397a(j) and the recordkeeping requirements of §60.5397a(i).

40 CFR Part 63 Subpart A, "General Provisions"

This subpart is applicable only provided that the facility is subject to one of the applicable subparts found under 40 CFR Part 63.

40 CFR 63 Subpart ZZZZ, "National Emission Standards for Hazardous Air Pollutant for Stationary Reciprocating Internal Combustion Engines (RICE)"

This regulation is also referred to as the RICE MACT and is applicable to any stationary reciprocating internal combustion engine that would be located at a major source of HAPs emissions or an area source of HAPs emissions. A stationary RICE at an area source of HAP emissions is existing if construction of that unit is commenced before June 12, 2006 (§63.6590(a)(1)(iii)). GEN-3 and LIFT-2 are therefore classified as a new RICE. Altogether, they are classified as a new, non-black-start 4SRB stationary RICE located at an area source; their status as *remote* has not been determined. ADEM has not adopted the area source provisions of Subpart ZZZZ, but to comply with federal regulations Sklar must meet the requirements under Subpart ZZZZ. §63.6590(c)(1) states that the requirements of Subpart ZZZZ are met by complying with Part 60 Subpart JJJJ. LIFT-1 is a reconstructed source rather than a new source. However, §63.6590(c)(1) applies to both reconstructed and new sources, so it would meet the requirements of Subpart ZZZZ by complying with the applicable requirements of Subpart JJJJ.

GEN-1, GEN-2, LIFT-3, LIFT-4, GEN-4, LIFT-5, & GEN-5 were first placed into service prior to the effective date for this regulation, and because the definition for *construction* in §63.2 specifically excludes the removal and reassembling of a unit as construction, so they would be classified as existing RICEs. Altogether, they would be classified as existing, non-black start, <500 HP, 4SRB stationary RICEs located at an area source. The engines' status as remote or non-remote was not determined. ADEM has not adopted the area source provisions of Subpart ZZZZ, but to comply with federal regulations Sklar must meet the requirements under Subpart ZZZZ. Sklar should meet the following EPA requirements for the above engines:

Emission Standards

Compliance with this subpart is met by meeting the following work/management practices specified in Table 2d (Nos. 10) of subpart ZZZZ upon startup (§63.6595(a)):

- For the engine, work/management practices involving:
  - Change oil and filter every 1,440 hours of operation or annually, whichever comes first (you have the option of utilizing an oil analysis program in order to extend the specified oil change requirements as specified in 40 CFR §63.6625(j)).
  - Inspect spark plugs every 1,440 hours of operation or annually, whichever comes first, and replace as necessary.
  - Inspect all hoses and belts every 1,440 hours of operation or annually, whichever comes first, and replace as necessary.

At all times, the engine shall be in compliance with the applicable emission limitations, operating limitations, and other requirements (§63.6605(a)). At all times an affected source must be operated and maintained, including associated air pollution control equipment and monitoring equipment, in a manner consistent with safety and good air pollution control practices for minimizing emissions (§63.6605(b)).

The engine's time spent at idle and the engine's startup time at startup shall be minimized to a period needed for appropriate and safe loading of the engines, not to exceed 30 minutes after which time the non-startup emission limitations apply (§63.6625(h)).

Compliance and Performance Test Methods and Procedures

No performance testing is required by Subpart ZZZZ for this engine since there are no Subpart ZZZZ numerical emission standards to comply with.

Emission Monitoring

Continuous compliance with the requirements of this subpart is met by complying with the requirements specified in Table 6 (No. 9) as follows:

- For all the RICE at facility, to show compliance with work/management practices:
  - Operate and maintain the stationary RICE according to the manufacturer's emission-related operation and maintenance instructions.
    OR
  - Develop and follow your own maintenance plan which provides, to the extent practicable, maintenance and operation of the engine in a manner consistent with good air pollution control practices for minimizing emissions (§63.6625(e)(8)).

Recordkeeping and Reporting Requirements

As per §63.6655, records used to show continuous compliance with items in Table 6 must be maintained. No reports are required for the engines because they have less than 500 HP.

RECOMMENDATIONS

This analysis indicates that Area 6 would meet continue to meet the requirements of all federal and state rules and regulations with the addition two new well sites and associated equipment. Based on increased potential emissions, Sklar has proposed 95 TPY NO_X and VOC limits for the facility to remain a synthetic minor source. The 95 TPY VOC limit would function to also keep Area 6 a synthetic minor or area source for HAPs (hexane) based on information provided in their application. Sklar has also proposed to operate several engines not subject to Subpart JJJJ with control devices in order to remain a synthetic minor source for NO_X and CO. Additionally, the naming convention of the permitted engines will be altered for the permit.

I recommend that the current SMOPs No. 502-0103-X001 & -X002 be rescinded and replaced with a new X003 permit, which will also include the two new wells proposed in the application.

June 29, 2017
Date

R. Jackson Rogers, Jr.
Industrial Minerals Section
Energy Branch
Air Division
ADEM

ATTACHMENT A

TABLES

Well	Lift Engine	New Name	Generator Engine	New Name
CCL&T 24-1 #1	163 HP Waukesha	LIFT-1	68 HP Arrow	GEN-1
CCL&T 13-11 #1	203 HP Caterpillar	LIFT-2	68 HP Arrow	GEN-2
CCL&T 13-15 #1	163 HP Waukesha	LIFT-3	145 HP Caterpillar	GEN-3
CCL&T 18-13 #1	163 HP Waukesha	LIFT-4	68 HP Arrow	GEN-4
CCL&T 14-9 #1	163 HP Waukesha	LIFT-5	68 HP Arrow	GEN-5

Table 1 – Engine listing

	Pollutant	Heaters	Flares	Engines	Total Emissions
Criteria Pollutant Emissions (TPY)	PM	0.11	0.78	0.42	1.31
	SO_2	0.01	0.30	0.05	0.36
	NO_X	1.66	29.82	106.66	138.14
	CO	1.17	162.24	128.54	291.95
	VOC	0.08	172.25	6.98	179.31
	Total HAPs	0.03	18.17	1.97	20.17
GHG Emissions (TPY)	CO_2	1,766.54	56,158.83	5,213.78	63,139.15
	N_2O	0.01	0.10	0.01	0.12
	CH_4	0.06	160.85	3.67	164.58
	Mass Sum	1,766.61	56,319.78	5,217.46	63,303.85
	CO_{2e}	1,770.67	60,208.97	5,308.58	67,288.21

Table 2 – Facility Potential Emissions after required control devices

	JJJJ Emission Standards					
	g/HP-hr			ppmvd at 15% O_2		
	NO_x	CO	VOC	NO_x	CO	VOC
New	1.0	2.0	0.7	82	270	60
Reconstructed	3.0	4.0	1.0	250	540	86

Table 3 – Subpart JJJJ Engine Emission Standards

ATTACHMENT B

EMISSION CALCULATIONS

LIFT-1

DATA:

		24-1 Gas Lift (LIFT-1)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,416 Btu/Scf	
FUEL H2S CONTENT	=	10.00 ppmv	
MAXIMUM ENGINE HP	=	163 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	1.30 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	16.57 g/HP-hr	3 g/HP-hr
CO	=	16.57 g/HP-hr	4 g/HP-hr
VOC	=	0.12 g/HP-hr	g/HP-hr
CH_2O	=	0.25 g/HP-hr	g/HP-hr
CH_4	=	1.02 g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 163 HP Engine Emissions Calculations

											Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	1.30 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=		0.05 Tons / Year	0.05 Tons / Year
SO_2	0.0006 lb / MMBtu	1.30 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	10 ppmv S / 3.44 ppmv S		=		0.01 Tons / Year	0.01 Tons / Year
NO_X	16.57 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		26.08 Tons / Year	4.72 Tons / Year
CO	16.57 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		26.08 Tons / Year	6.30 Tons / Year
VOC	0.12 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		0.19 Tons / Year	0.19 Tons / Year
CH_2O	0.2500 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		0.39 Tons / Year	0.39 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	1.30 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		0.07 Tons / Year	0.07 Tons / Year
CO_2	1.30 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=		668.12 Tons / Year	668.12 Tons / Year
N_2O	1.30 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=		0.00 Tons / Year	0.00 Tons / Year
CH_4	1.02 g / HP-Hr	163.000 HP	1 Lb / 453.6 g	8,760 Hr / Year		1 Ton / 2000 Lbs			=		1.61 Tons / Year	1.61 Tons / Year
Mass Sum	668.12 Tons / Year / CO_2	+	0.0013 Tons / Year / N_2O	+		1.6054 Tons / Year / CH_4			=		669.72 Tons / Year	669.72 Tons / Year
CO_2e	668.12 TPY*1 / 668.12 / CO_2	+	0.0013 TPY*298 / 0.38 / N_2O	+		1.605 TPY*25 / 40.14 / CH_4			=		708.63 Tons / Year	708.63 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

GEN-1

DATA:

		24-1 Generator (GEN-1)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,416 Btu/Scf	
FUEL H2S CONTENT	=	10.00 ppmv	
MAXIMUM ENGINE HP	=	68 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	0.54 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	14.4 g/HP-hr	g/HP-hr
CO	=	16.3 g/HP-hr	g/HP-hr
VOC	=	3 g/HP-hr	g/HP-hr
CH_2O	=	0.07 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 68 HP Engine Emissions Calculations

											Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=	0.02 Tons / Year	0.02 Tons / Year
SO_2	0.0006 lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	10 ppmv S / 3.44 ppmv S		=	0.00 Tons / Year	0.00 Tons / Year
NO_X	14.4 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	9.46 Tons / Year	9.46 Tons / Year
CO	16.3 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	10.70 Tons / Year	10.70 Tons / Year
VOC	3.00 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	1.97 Tons / Year	1.97 Tons / Year
CH_2O	0.0700 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	0.05 Tons / Year	0.05 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	0.54 MMBtu / Hr		8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	0.03 Tons / Year	0.03 Tons / Year
CO_2	0.54 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	278.72 Tons / Year	278.72 Tons / Year
N_2O	0.54 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	0.00 Tons / Year	0.00 Tons / Year
CH_4	0.54 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	0.01 Tons / Year	0.01 Tons / Year
Mass Sum	278.72 Tons / Year / CO_2	+	0.0005 Tons / Year / N_2O	+			0.0053 Tons / Year / CH_4		=	278.73 Tons / Year	278.73 Tons / Year
CO_2e	278.72 TPY*1 / 278.72 / CO_2	+	0.0005 TPY*298 / 0.16 / N_2O	+			0.005 TPY*25 / 0.13 / CH_4		=	279.01 Tons / Year	279.01 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

24-1 Flare

Data	Total		Separator Gas		Tank Gas		~~Pilot Gas~~		GWP (11/29/2013)		40 CFR Part 98 Sub C GHG Emission Factors (Table C-1)		
Volume	**12,701.740**	scf/hr (Ind.)	**300.0**	Mscf/day	**4.8**	Mscf/day	**0.0**	~~Mscf/day~~	N_20=	298			
H_2S mol%	0.0010%	mol%	0.0010%	mol%	0.0000%	mol%	~~0.0000%~~	~~mol%~~	CO_2=	1	N_20=	0.0001	kg/MMBtu
Heat Content	1427.25	Btu/scf (Ind)	1416.00	Btu/scf (Ind)	2124.62	Btu/scf (Ind)	~~2500.00~~	~~Btu/scf (Ind)~~	CH_4=	25	AP 42 Emissions Factors[7]		
VOC MW	**10.75**	lb/lb-mol[2]	**10.49**	lb/lb-mol[2]	**26.76**	lb/lb-mol[2]	**43.24**	~~lb/lb-mol~~[2]			NO_X=	0.068	lb/MMBtu
CO_2	**0.81%**	mol%	**0.82%**	mol%	**0.18%**	mol%	**0.00%**	~~mol%~~			CO=	0.37	lb/MMBtu
CH_4	**61.80%**	mol%	**62.31%**	mol%	**30.03%**	mol%	**0.00%**	~~mol%~~			PM_1=	40	µg/L
C_6	**1.07**	lb/lb-mol[2]	**1.06**	lb/lb-mol[2]	**1.78**	lb/lb-mol[2]	**0.00**	~~lb/lb-mol~~[2]					
OP Hours	8760	Hrs							(Ind. STP)	scf/lbmol=	380.67	60 °F	14.65 psia
Destruction Eff	**98.00%**	DRE	Heat Input		**18.13**	MMBtu/hr[1]			(EPA STP)	scf/lbmol=	385.5	68 °F	14.696 psia

Potential Flare Emission Calculations

Pollutants

PM_1	40	µg	12701.7	scf (Ind.)	2.2E-9	lb	8,760	Hr	1 Ton	28.31685	L	1.01	scf(EPA)	=	**0.141**	**Tons**
	L		Hr		µg		Year		2,000 Lb	scf (EPA)		1	scf(Ind.)		**Year**	
SO_2	168.3	Lb SO_2[4]	12.702	MScf (Ind.)	0.001%	H_2S Mol%	8,760	Hr	1 Ton					=	**0.092**	**Tons**
	MScf (Ind.)		Hr				Year		2,000 Lb						**Year**	
NO_X	0.068	lb	18.129	MMBtu	8,760	Hr	1 Ton							=	**5.399**	**Tons**
	MMBtu		Hr		Year		2,000 Lb								**Year**	
CO	0.37	lb	18.129	MMBtu	8,760	Hr	1 Ton							=	**29.379**	**Tons**
	MMBtu		Hr		Year		2,000 Lb								**Year**	
VOC[5]	12,701.7	Scf (Ind.)	1	lb-mol	10.75	Lb VOC	8,760	Hr	1 Ton	2.00%	Inv. DRE			=	**31.422**	**Tons**
	Hr		380.67	scf (Ind.)	Lb-Mole		Year		2,000 Lb						**Year**	
HAPs[8]	12,701.7	Scf (Ind.)	1	lb-mol	1.07	Lb C_6	8,760	Hr	1 Ton	2.00%	Inv. DRE			=	**3.140**	**Tons**
	Hr		380.67	scf (Ind.)	Lb-Mole		Year		2,000 Lb						**Year**	
CO_2[5,6] of Combustion	98.00%	DRE	1.11E+08	Scf (Ind.)	1.61	lb-mol CO_2 (stoich.)	1	lb-mol gas	44.01	lb CO_2	1 Ton			=	**10,132.14**	**Tons**
			Yr		1	lb-mol gas (stoich.)	380.67	scf (Ind.)	lb-mole CO_2		2,000 Lb				**Year**	
CO_2 of Fuel	1.11E+08	Scf (Ind.)	0.81%	mol% CO_2	1	lb-mol	44.01	Lb CO2	1 Ton					=	**52.09**	**Tons**
	Yr				380.67	scf (Ind.)	Lb-mole		2,000 Lb						**Year**	
N_2O	0.001	M Ton	0.001427	MMBtu	12,701.7	Scf (Ind.)	0.0001	kg	8,760	Hr	1.1023	Tons		=	**0.0175**	**Tons**
	kg		Scf (Ind.)		Hr		MMBtu		Year		1 Metric Ton				**Year**	
CH_4 Uncombusted	1.11E+08	Scf (Ind.)	2.00%	Inv. DRE	61.80%	mol% CH_4	1	lb-mol	16.043	Lb CH4	1 Ton			=	**28.98**	**Tons**
	Yr						380.675	scf (Ind.)	Lb-mole		2,000 Lb				**Year**	
Mass Sum	10,184.23	Tons		+	0.0175	Tons		+	28.98	Tons				=	**10,213.22**	**Tons**
	Year				Year				Year						**Year**	
	CO2				N2O				CH4							
CO_2e	10,184.23	TPY	X 1		0.0175	TPY	X 298		28.98	TP	X 25			=	**10,913.91**	**Tons**
	10,184.23			+	5.22			+	724.46						**Year**	
	CO2				N2O				CH4							

[1] Rated Heat Capacity (MMBtu/Hr) = Flowrate (Scf/Hr) * Heat Content (Btu/Scf) * (MMBtu/10^6 Btu)

[2] VOC (Lb/Lb-mole) = Σ(Mole% of Each Compound)* (1%/100)*MW of Each Compound) -See Flare GHG Spreed Sheet for gas analysis

[3] Has to be maintained <500 lb/hr or 20 ppbv offsite concentration could potentially be exceeded

H_2S (Lb/hr) = Volume (Scf/hr) * (1 lb-mol/380.67) *(H_2S mol%) * (34.08 Lb H_2S/Lb-mol)

[4] SO_2 Conversion Factor 168.3 Lb SO_2/MScf of Gas

=(1,000 Scf/MScf) *(1Lb-Mole/380.67 Scf)* (64.066 Lb SO_2/Lb-Mole)

[5] Assuming the flare is 98% efficient

[6] Calculated using the gas analysis:

$\Sigma Y_j * R_j$ where, Y_j= mole fraction of gas hydrocarbon constituents' j (such as methane, ethane, propane, carbon dioxide, etc.) and R_j= number of carbon atoms in gas hydrocarbon constituent j: 1 for methane and carbon dioxide, 2 for ethane, 3 for propane, etc.

[7] Flare assumed to be "lightly smoking" in AP-42 table 13.5-1

[8] Hexane is a HAP. Assume Hexanes+ or Hexane are HAPS

LIFT-2

DATA:

		13-11 Gas Lift (LIFT-2)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,462 Btu/Scf	
FUEL H2S CONTENT	=	4.00 ppmv	
MAXIMUM ENGINE HP	=	203 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	1.62 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/ HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	16.57 g/HP-hr	1 g/HP-hr
CO	=	16.57 g/HP-hr	2 g/HP-hr
VOC	=	0.12 g/HP-hr	g/HP-hr
CH_2O	=	0.25 g/HP-hr	g/HP-hr
CH_4	=	1.02 g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 203 HP Engine Emissions Calculations

											Uncontrolled	Controlled
PM	0.0095 Lb/MMBtu	1.62 MMBtu/Hr	8760 Hrs/Year	1 Ton/2000 Lb		S.F.			=		0.07 Tons/Year	0.07 Tons/Year
SO_2	0.0006 lb/MMBtu	1.62 MMBtu/Hr	8760 Hrs/Year	1 Ton/2000 Lb		S.F.	4 ppmv S / 3.44 ppmv S		=		0.00 Tons/Year	0.00 Tons/Year
NO_X	16.57 g/HP-Hr	203.00 HP	1 Lb/453.6 g	8,760 Hr/Year		1 Ton/2000 Lb		S.F.	=		32.48 Tons/Year	1.96 Tons/Year
CO	16.57 g/HP-Hr	203.00 HP	1 Lb/453.6 g	8,760 Hr/Year		1 Ton/2000 Lb		S.F.	=		32.48 Tons/Year	3.92 Tons/Year
VOC	0.12 g/HP-Hr	203.00 HP	1 Lb/453.6 g	8,760 Hr/Year		1 Ton/2000 Lb		S.F.	=		0.24 Tons/Year	0.24 Tons/Year
CH_2O	0.2500 g/HP-Hr	203.00 HP	1 Lb/453.6 g	8,760 Hr/Year		1 Ton/2000 Lb		S.F.	=		0.49 Tons/Year	0.49 Tons/Year
non-CH_2O HAPs	0.0120 lb/MMBtu	1.62 MMBtu/Hr		8,760 Hr/Year		1 Ton/2000 Lb		S.F.	=		0.09 Tons/Year	0.09 Tons/Year
CO_2	1.62 MMBtu/Hr	53.06 kg/MMBtu	0.001 Metric Ton/kg	8,760 Hr/Year			1.10231 Tons/1 M Ton		=		832.07 Tons/Year	832.07 Tons/Year
N_2O	1.62 MMBtu/Hr	0.0001 kg/MMBtu	0.001 Metric Ton/kg	8,760 Hr/Year			1.10231 Tons/1 M Ton		=		0.00 Tons/Year	0.00 Tons/Year
CH_4	1.02 g/HP-Hr	203.000 HP	1 Lb/453.6 g	8,760 Hr/Year			1 Ton/2000 Lbs		=		2.00 Tons/Year	2.00 Tons/Year
Mass Sum	832.07 Tons/Year CO_2	+	0.0016 Tons/Year N_2O	+		1.9994 Tons/Year CH_4			=		834.07 Tons/Year	834.07 Tons/Year
CO_2e	832.07 TPY*1 / 832.07 CO_2	+	0.0016 TPY*298 / 0.47 N_2O	+		1.999 TPY*25 / 49.98 CH_4			=		882.53 Tons/Year	882.53 Tons/Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

GEN-2

DATA:

		13-11 Generator (GEN-2)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,462 Btu/Scf	
FUEL H2S CONTENT	=	4.00 ppmv	
MAXIMUM ENGINE HP	=	68 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	0.54 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	14.4 g/HP-hr	g/HP-hr
CO	=	16.3 g/HP-hr	g/HP-hr
VOC	=	3 g/HP-hr	g/HP-hr
CH_2O	=	0.07 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 68 HP Engine Emissions Calculations

										Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=	0.02 Tons / Year	0.02 Tons / Year
SO_2	0.0006 lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	4 ppmv S / 3.44 ppmv S		=	0.00 Tons / Year	0.00 Tons / Year
NO_X	14.4 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	9.46 Tons / Year	9.46 Tons / Year
CO	16.3 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	10.70 Tons / Year	10.70 Tons / Year
VOC	3.00 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	1.97 Tons / Year	1.97 Tons / Year
CH_2O	0.0700 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.05 Tons / Year	0.05 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	0.54 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.03 Tons / Year	0.03 Tons / Year
CO_2	0.54 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	278.72 Tons / Year	278.72 Tons / Year
N_2O	0.54 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.00 Tons / Year	0.00 Tons / Year
CH_4	0.54 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.01 Tons / Year	0.01 Tons / Year
Mass Sum	278.72 Tons / Year / CO_2	+	0.0005 Tons / Year / N_2O	+		0.0053 Tons / Year / CH_4			=	278.73 Tons / Year	278.73 Tons / Year
CO_2e	278.72 TPY*1 / 278.72 / CO_2	+	0.0005 TPY*298 / 0.16 / N_2O	+		0.005 TPY*25 / 0.13 / CH_4			=	279.01 Tons / Year	279.01 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

LIFT-3

DATA:			
		13-15 Power Oil (LIFT-3)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,359 Btu/Scf	
FUEL H2S CONTENT	=	4.50 ppmv	
MAXIMUM ENGINE HP	=	163 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	1.30 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	13.5 g/HP-hr	0.5 g/HP-hr
CO	=	17 g/HP-hr	2 g/HP-hr
VOC	=	0.35 g/HP-hr	g/HP-hr
CH_2O	=	0.05 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors
(lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C
Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Uncontrolled 163 HP Engine Emissions Calculations

														Uncontrolled
PM	0.0095 Lb / MMBtu		1.30 MMBtu / Hr		8760 Hrs / Year		1 Ton / 2000 Lb		S.F.			=	**0.05 Tons / Year**
SO_2	0.0006 lb / MMBtu		1.30 MMBtu / Hr		8760 Hrs / Year		1 Ton / 2000 Lb		S.F.	4.5 ppmv S / 3.44 ppmv S		=	**0.00 Tons / Year**
NO_X	13.5 g / HP-Hr		163.00 HP		1 Lb / 453.6 g		8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	**21.25 Tons / Year**
CO	17 g / HP-Hr		163.00 HP		1 Lb / 453.6 g		8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	**26.76 Tons / Year**
VOC	0.35 g / HP-Hr		163.00 HP		1 Lb / 453.6 g		8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	**0.55 Tons / Year**
CH_2O	0.0500 g / HP-Hr		163.00 HP		1 Lb / 453.6 g		8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	**0.08 Tons / Year**
non-CH_2O HAPs	0.0120 lb / MMBtu		1.30 MMBtu / Hr				8,760 Hr / Year		1 Ton / 2000 Lb		S.F.	=	**0.07 Tons / Year**
CO_2	1.30 MMBtu / Hr		53.06 kg / MMBtu		0.001 Metric Ton / kg		8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	**668.12 Tons / Year**
N_2O	1.30 MMBtu / Hr		0.0001 kg / MMBtu		0.001 Metric Ton / kg		8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	**0.00 Tons / Year**
CH_4	1.30 MMBtu / Hr		0.001 kg / MMBtu		0.001 Metric Ton / kg		8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	**0.01 Tons / Year**
Mass Sum	668.12 Tons / Year / CO_2	+	0.0013 Tons / Year / N_2O	+			0.0126 Tons / Year / CH_4					=	**668.13 Tons / Year**
CO_2e	668.12 TPY*1 / 668.12 / CO_2	+	0.0013 TPY*298 / 0.38 / N_2O	+			0.013 TPY*25 / 0.31 / CH_4					=	**668.81 Tons / Year**

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

GEN-3

DATA:

		13-15 generator (GEN-3)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,359 Btu/Scf	
FUEL H2S CONTENT	=	4.50 ppmv	
MAXIMUM ENGINE HP	=	145 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	1.16 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	13.48 g/HP-hr	1 g/HP-hr
CO	=	13.46 g/HP-hr	2 g/HP-hr
VOC	=	0.22 g/HP-hr	0.2 g/HP-hr
CH_2O	=	0.07 g/HP-hr	0.07 g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 145 HP Engine Emissions Calculations

											Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	1.16 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=		0.05 Tons / Year	0.05 Tons / Year
SO_2	0.0006 lb / MMBtu	1.16 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	4.5 / 3.44	ppmv S / ppmv S	=		0.00 Tons / Year	0.00 Tons / Year
NO_X	13.48 g / HP-Hr	145.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		18.87 Tons / Year	1.40 Tons / Year
CO	13.46 g / HP-Hr	145.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		18.85 Tons / Year	2.80 Tons / Year
VOC	0.22 g / HP-Hr	145.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		0.31 Tons / Year	0.28 Tons / Year
CH_2O	0.0700 g / HP-Hr	145.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		0.10 Tons / Year	0.10 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	1.16 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=		0.06 Tons / Year	0.06 Tons / Year
CO_2	1.16 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=		594.34 Tons / Year	594.34 Tons / Year
N_2O	1.16 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=		0.00 Tons / Year	0.00 Tons / Year
CH_4	1.16 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=		0.01 Tons / Year	0.01 Tons / Year
Mass Sum	594.34 Tons / Year / CO_2	+	0.0011 Tons / Year / N_2O	+		0.0112 Tons / Year / CH_4			=		594.35 Tons / Year	594.35 Tons / Year
CO_2e	594.34 TPY*1 / 594.34 / CO_2	+	0.0011 TPY*298 / 0.33 / N_2O	+		0.011 TPY*25 / 0.28 / CH_4			=		594.95 Tons / Year	594.95 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

LIFT-4

DATA:

		18-13 Power Oil	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,412 Btu/Scf	
FUEL H2S CONTENT	=	6.2 ppmv	
MAXIMUM ENGINE HP	=	163 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	1.30 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	

EMISSION FACTORS (EF)		MANUFACTURER'S EF Uncontrolled	MANUFACTURER'S EF Controlled
NO_X	=	13.5 g/HP-hr	0.5 g/HP-hr
CO	=	17 g/HP-hr	2 g/HP-hr
VOC	=	0.35 g/HP-hr	g/HP-hr
CH_2O	=	0.05 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 163 HP Engine Emissions Calculations

										Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	1.30 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=	0.05 Tons / Year	0.05 Tons / Year
SO_2	0.0006 lb / MMBtu	1.30 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	6.16667 / 3.44	ppmv S / ppmv S	=	0.01 Tons / Year	0.01 Tons / Year
NO_X	13.5 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	21.25 Tons / Year	0.79 Tons / Year
CO	17 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	26.76 Tons / Year	3.15 Tons / Year
VOC	0.35 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.55 Tons / Year	0.55 Tons / Year
CH_2O	0.0500 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.08 Tons / Year	0.08 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	1.30 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.07 Tons / Year	0.07 Tons / Year
CO_2	1.30 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	668.12 Tons / Year	668.12 Tons / Year
N_2O	1.30 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	0.00 Tons / Year	0.00 Tons / Year
CH_4	1.30 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year			1.10231 Tons / 1 M Ton		=	0.01 Tons / Year	0.01 Tons / Year
Mass Sum	668.12 Tons / Year / CO_2	+	0.0013 Tons / Year / N_2O	+	0.0126 Tons / Year / CH_4				=	668.13 Tons / Year	668.13 Tons / Year
CO_2e	668.12 TPY*1 / 668.12 / CO_2	+	0.0013 TPY*298 / 0.38 / N_2O	+	0.013 TPY*25 / 0.31 / CH_4				=	668.81 Tons / Year	668.81 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

GEN-4

DATA:

		18-13 Generator (GEN-4)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,412 Btu/Scf	
FUEL H2S CONTENT	=	6.17 ppmv	
MAXIMUM ENGINE HP	=	68 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	0.54 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	

EMISSION FACTORS (EF)		MANUFACTURER'S EF Uncontrolled	MANUFACTURER'S EF Controlled
NO_X	=	14.4 g/HP-hr	0.5 g/HP-hr
CO	=	16.3 g/HP-hr	1 g/HP-hr
VOC	=	0.5 g/HP-hr	g/HP-hr
CH_2O	=	0.1 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 68 HP Engine Emissions Calculations

										Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=	0.02 Tons / Year	0.02 Tons / Year
SO_2	0.0006 lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	6.16667 / 3.44	ppmv S	=	0.00 Tons / Year	0.00 Tons / Year
NO_X	14.4 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	9.46 Tons / Year	0.33 Tons / Year
CO	16.3 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	10.70 Tons / Year	0.66 Tons / Year
VOC	0.50 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.33 Tons / Year	0.33 Tons / Year
CH_2O	0.1000 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.07 Tons / Year	0.07 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	0.54 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.03 Tons / Year	0.03 Tons / Year
CO_2	0.54 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	278.72 Tons / Year	278.72 Tons / Year
N_2O	0.54 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.00 Tons / Year	0.00 Tons / Year
CH_4	0.54 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.01 Tons / Year	0.01 Tons / Year
Mass Sum	278.72 Tons / Year / CO_2	+	0.0005 Tons / Year / N_2O	+		0.0053 Tons / Year / CH_4			=	278.73 Tons / Year	278.73 Tons / Year
CO_2e	278.72 TPY*1 / 278.72 / CO_2	+	0.0005 TPY*298 / 0.16 / N_2O	+		0.005 TPY*25 / 0.13 / CH_4			=	279.01 Tons / Year	279.01 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

LIFT-5

DATA:			
		14-XX Power Oil (LIFT-4)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,412 Btu/Scf	
FUEL H2S CONTENT	=	6.2 ppmv	
MAXIMUM ENGINE HP	=	163 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	1.30 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	
EMISSION FACTORS (EF)		MANUFACTURER'S EF	
		Uncontrolled	Controlled
NO_X	=	13.5 g/HP-hr	0.5 g/HP-hr
CO	=	17 g/HP-hr	2 g/HP-hr
VOC	=	0.35 g/HP-hr	g/HP-hr
CH_2O	=	0.05 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors
(lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 163 HP Engine Emissions Calculations

										Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	1.30 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=	0.05 Tons / Year	0.05 Tons / Year
SO_2	0.0006 lb / MMBtu	1.30 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	6.16667 / 3.44	ppmv S / ppmv S	=	0.01 Tons / Year	0.01 Tons / Year
NO_X	13.5 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	21.25 Tons / Year	0.79 Tons / Year
CO	17 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	26.76 Tons / Year	3.15 Tons / Year
VOC	0.35 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.55 Tons / Year	0.55 Tons / Year
CH_2O	0.0500 g / HP-Hr	163.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.08 Tons / Year	0.08 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	1.30 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.07 Tons / Year	0.07 Tons / Year
CO_2	1.30 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	668.12 Tons / Year	668.12 Tons / Year
N_2O	1.30 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.00 Tons / Year	0.00 Tons / Year
CH_4	1.30 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.01 Tons / Year	0.01 Tons / Year
Mass Sum	668.12 Tons / Year / CO_2	+	0.0013 Tons / Year / N_2O	+		0.0126 Tons / Year / CH_4			=	668.13 Tons / Year	668.13 Tons / Year
CO_2e	668.12 TPY*1 / 668.12 / CO_2	+	0.0013 TPY*298 / 0.38 / N_2O	+		0.013 TPY*25 / 0.31 / CH_4			=	668.81 Tons / Year	668.81 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

GEN-5

DATA:

		14-XX Generator (GEN-5)	
ENGINE TYPE	=	4SRB	NG
FUEL HEAT CONTENT	=	1,412 Btu/Scf	
FUEL H2S CONTENT	=	6.17 ppmv	
MAXIMUM ENGINE HP	=	68 HP	
ENGINE OP HOURS	=	8,760 Hr	
ENGINE RATING	=	0.54 MMBtu/hr	
BRAKE-SPECIFIC FUEL CONSUMPTION	=	8,000 Btu/HP-hr	
CALCULATION BASIS	=	Controlled and Uncontrolled	

EMISSION FACTORS (EF)		MANUFACTURER'S EF Uncontrolled	MANUFACTURER'S EF Controlled
NO_X	=	14.4 g/HP-hr	0.5 g/HP-hr
CO	=	16.3 g/HP-hr	1 g/HP-hr
VOC	=	0.5 g/HP-hr	g/HP-hr
CH_2O	=	0.1 g/HP-hr	g/HP-hr
CH_4	=	g/HP-hr	g/HP-hr

AP-42 Emission Factors (lb/MMBtu)

Type	PM	SO_2[1]	NO_X	CO	VOC	CH_2O	Other HAPs
Diesel	3.10E-1	[By Mass]	4.41E+0	9.50E-1	3.50E-1	1.18E-3	2.69E-3
2SLB	3.84E-2	5.88E-4	3.17E+0	3.86E-1	1.20E-1	5.52E-2	2.53E-2
4SLB	7.71E-5	5.88E-4	4.08E+0	3.17E-1	1.18E-1	5.28E-2	2.10E-2
4SRB	9.50E-3	5.88E-4	2.27E+0	3.72E+0	2.96E-2	2.05E-2	1.20E-2

40 CFR Part 98 Subpart C Greenhouse Gas Emission Factors
Tables C-1 & C-2
(kg/MMBtu)

	N_2O	CO_2	CH_4
Diesel	0.0006	75.04	0.003
NG	0.0001	53.06	0.001
LPG	0.0006	62.72	0.003
Propane	0.0006	61.46	0.003

GWP	
N_2O=	298
CO_2=	1
CH_4=	25

Controlled and Uncontrolled 68 HP Engine Emissions Calculations

										Uncontrolled	Controlled
PM	0.0095 Lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.			=	0.02 Tons / Year	0.02 Tons / Year
SO_2	0.0006 lb / MMBtu	0.54 MMBtu / Hr	8760 Hrs / Year	1 Ton / 2000 Lb		S.F.	6.16667 / 3.44	ppmv S / ppmv S	=	0.00 Tons / Year	0.00 Tons / Year
NO_X	14.4 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	9.46 Tons / Year	0.33 Tons / Year
CO	16.3 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	10.70 Tons / Year	0.66 Tons / Year
VOC	0.50 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.33 Tons / Year	0.33 Tons / Year
CH_2O	0.1000 g / HP-Hr	68.00 HP	1 Lb / 453.6 g	8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.07 Tons / Year	0.07 Tons / Year
non-CH_2O HAPs	0.0120 lb / MMBtu	0.54 MMBtu / Hr		8,760 Hr / Year	1 Ton / 2000 Lb		S.F.		=	0.03 Tons / Year	0.03 Tons / Year
CO_2	0.54 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	278.72 Tons / Year	278.72 Tons / Year
N_2O	0.54 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.00 Tons / Year	0.00 Tons / Year
CH_4	0.54 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year		1.10231 Tons / 1 M Ton			=	0.01 Tons / Year	0.01 Tons / Year
Mass Sum	278.72 Tons / Year / CO_2	+	0.0005 Tons / Year / N_2O	+		0.0053 Tons / Year / CH_4			=	278.73 Tons / Year	278.73 Tons / Year
CO_2e	278.72 TPY*1 / 278.72 / CO_2	+	0.0005 TPY*298 / 0.16 / N_2O	+		0.005 TPY*25 / 0.13 / CH_4			=	279.01 Tons / Year	279.01 Tons / Year

[1] EPA AP-42 factors assume gas to have 2000 gr S/MMScf (at EPA STP). This equates to 3.44 ppmv S, assuming ideal gas. AP-42 factor can be corrected to sulfur value of facility gas by comparing actual sulfur values to EPA reference point. Assume ppmv H_2S = ppmv S (true if H_2S = TRS and TRS is entirely monosulfur compounds).

Heater Treater at 24-1

Data:					AP-42 EF (Propane)			Based on NG with Btu/Content of 1020			
H_2S mol%	0.00%	mol%			PM=	7.6	Lb/MMScf		GWP*		*Revised 11/29/2013
Op Hours	8760	Hrs			NO_X=	150	Lb/MMScf		N_2O=	298	
Heat Content	2,500	Btu/scf (Ind.)			CO=	84	Lb/MMScf		CO_2=	1	
Flowrate	**0.200**	MScf/Hr (Ind.)			VOC=	5.5	Lb/MMScf		CH_4=	25	
Heat Input	500,000	Btu/hr			HAP=	1.89	Lb/MMScf				
					SO_2=	0.60	Lb/MMScf				
Use btu/scf (EPA) for PM, NOx, CO, VOC. Factors for EPA STP (also ADEM STP). SO2 factor already for Industry STP (from Al. Oil & Gas Board)					(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_3			(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_1			
Ind. STP:	60	°F	14.65	psia	N_20=	0.0006	kg/MMBtu	N_20=	0.0001	kg/MMBtu	
EPA STP:	68	°F	14.696	psia	CO_2=	61.46	kg/MMBtu	CO_2=	53.06	kg/MMBtu	
Heat Content	2,470	Btu/scf (EPA)			CH_4=	0.003	kg/MMBtu	CH_4=	0.001	kg/MMBtu	
Fuel HHV Correction Factor	**2.421**										

Heater Emission Calculations

Pollutants															
PM	7.6	Lb	0.500	MMBtu	Scf (EPA)	8,760	Hr	1 Ton	2.421	=	**0.016**	**Tons**
	MMScf (EPA)		Hr		2,470	Btu	Year	2,000 Lb			**Year**	
SO_2	0.60	Lb	0.500	MMBtu	Scf (EPA)	8,760	Hr	1 Ton	2.421	=	**0.001**	**Tons**
	MMScf (EPA)		Hr		2,470	Btu	Year	2,000 Lb			**Year**	
NO_X	150	Lb	0.500	MMBtu	Scf (EPA)	8,760	Hr	1 Ton	2.421	=	**0.322**	**Tons**
	MMScf (EPA)		Hr		2,470	Btu	Year	2,000 Lb			**Year**	
CO	84	Lb	0.500	MMBtu	Scf (EPA)	8,760	Hr	1 Ton	2.421	=	**0.180**	**Tons**
	MMScf (EPA)		Hr		2,470	Btu	Year	2,000 Lb			**Year**	
VOC	5.5	Lb	0.500	MMBtu	Scf (EPA)	8,760	Hr	1 Ton	2.421	=	**0.012**	**Tons**
	MMScf (EPA)		Hr		2,470	Btu	Year	2,000 Lb			**Year**	
HAP	1.89	Lb	0.500	MMBtu	Scf (EPA)	8,760	Hr	1 Ton	2.421	=	**0.004**	**Tons**
	MMScf (EPA)		Hr		2,470	Btu	Year	2,000 Lb			**Year**	
CO_2	0.5	MMBtu	61.46	kg	0.001	Metric Ton	8,760	Hr	1.1023	Tons	=	**296.73**	**Tons**
	Hr		MMBtu		kg		Year		1 Metric Ton			**Year**	
N_2O	0.5	MMBtu	0.0006	kg	0.001	Metric Ton	8,760	Hr	1.1023	Tons	=	**0.00290**	**Tons**
	Hr		MMBtu		kg		Year		1 Metric Ton			**Year**	
CH_4	0.5	MMBtu	0.003	kg	0.001	Metric Ton	8,760	Hr	1.1023	Tons	=	**0.01448**	**Tons**
	Hr		MMBtu		kg		Year		1 Metric Ton			**Year**	
Mass Sum	296.73	Tons	+		0.0029	Tons	+		0.0145	Tons	=	**296.75**	**Tons**
	Year				Year				Year			**Year**	
	CO_2				**N_2O**				**CH_4**				
CO_2e	296.73	TPY	X 1		0.0029	TPY	X 298		0.0145	TPY	X 25	=	**297.96**	**Tons**
	296.73		+		0.86		+		0.36				**Year**	
	CO_2				**N_2O**				**CH_4**					

[1] AP-42 emission factors taken from Chapter 1.4. Based on natural gas with 1020 btu/scf, and corrected in calculations. From Chapter 1.5, propane emission factors are equivalent on a heat basis to methane factors, except the NO_X factor is 1.5x higher.

Line Heater at 24-1

Data:				
H_2S mol%	0.00%	mol%		
Op Hours	8760	Hrs		
Heat Content	2,500	Btu/scf (Ind.)		
Flowrate	0.300	MScf/Hr (Ind.)		
Heat Input	750,000	Btu/hr		
Use btu/scf(EPA) for PM, NOx, CO, VOC. Factors for EPA STP (also ADEM STP). SO2 factor already for Industry STP (from Al. Oil & Gas Board)				
Ind. STP:	60	˚F	14.65	psia
EPA STP:	68	˚F	14.696	psia
Heat Content	2,470	Btu/scf (EPA)		
Fuel HHV Correction Factor	2.421			

AP-42 EF (Propane)		
PM=	7.6	Lb/MMScf
NO_X=	150	Lb/MMScf
CO=	84	Lb/MMScf
VOC=	5.5	Lb/MMScf
HAP=	1.89	Lb/MMScf
SO_2=	0.60	Lb/MMScf

Based on NG with Btu/Content of 1020

GWP*	
N_2O=	298
CO_2=	1
CH_4=	25

*Revised 11/29/2013

(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_3			(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_1		
N_20=	0.0006	kg/MMBtu	N_20=	0.0001	kg/MMBtu
CO_2=	61.46	kg/MMBtu	CO_2=	53.06	kg/MMBtu
CH_4=	0.003	kg/MMBtu	CH_4=	0.001	kg/MMBtu

Heater Emission Calculations

Pollutants								
PM	7.6 Lb / MMScf (EPA)	0.750 MMBtu / Hr	Scf (EPA) / 2,470 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	2.421	=	**0.024 Tons / Year**
SO_2	0.60 Lb / MMScf (EPA)	0.750 MMBtu / Hr	Scf (EPA) / 2,470 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	2.421	=	**0.002 Tons / Year**
NO_X	150 Lb / MMScf (EPA)	0.750 MMBtu / Hr	Scf (EPA) / 2,470 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	2.421	=	**0.483 Tons / Year**
CO	84 Lb / MMScf (EPA)	0.750 MMBtu / Hr	Scf (EPA) / 2,470 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	2.421	=	**0.271 Tons / Year**
VOC	5.5 Lb / MMScf (EPA)	0.750 MMBtu / Hr	Scf (EPA) / 2,470 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	2.421	=	**0.018 Tons / Year**
HAP	1.89 Lb / MMScf (EPA)	0.750 MMBtu / Hr	Scf (EPA) / 2,470 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	2.421	=	**0.006 Tons / Year**
CO_2	0.75 MMBtu / Hr	61.46 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**445.10 Tons / Year**
N_2O	0.75 MMBtu / Hr	0.0006 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.00435 Tons / Year**
CH_4	0.75 MMBtu / Hr	0.003 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.02173 Tons / Year**
Mass Sum	445.10 Tons / Year (**CO_2**) +		0.0043 Tons / Year (**N_2O**) +		0.0217 Tons / Year (**CH_4**)		=	**445.13 Tons / Year**
CO_2e	445.10 TPY X 1 = 445.10 (**CO_2**) +		0.0043 TPY X 298 = 1.29 (**N_2O**) +		0.0217 TPY X 25 = 0.54 (**CH_4**)		=	**446.94 Tons / Year**

[1] AP-42 emission factors taken from Chapter 1.4. Based on natural gas w ith 1020 btu/scf, and corrected in calculations. From Chapter 1.5, propane emission factors are equivalent on a heat basis to methane factors, except the NO_X factor is 1.5x higher.

Heater Treater at 13-11

Data:				AP-42 EF (NG)			Based on NG with Btu/Content of 1020		
H_2S mol%	0.00%	mol%		PM=	7.6	Lb/MMScf	GWP*		*Revised 11/29/2013
Op Hours	8760	Hrs		NO_X=	100	Lb/MMScf	N_2O=	298	
Heat Content	1,462	Btu/scf (Ind.)		CO=	84	Lb/MMScf	CO_2=	1	
Flowrate	0.342	MScf/Hr (Ind.)		VOC=	5.5	Lb/MMScf	CH_4=	25	
Heat Input	500,000	Btu/hr		HAP=	1.89	Lb/MMScf			
Use btu/scf(EPA) for PM, NOx, CO, VOC. Factors for EPA STP (also ADEM STP). SO2 factor already for Industry STP (from Al. Oil & Gas Board)				SO_2=	0.60	Lb/MMScf			
				(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_3			(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_1		
Ind. STP:	60	˚F	14.65 psia	N_2O=	0.0006	kg/MMBtu	N_2O=	0.0001	kg/MMBtu
EPA STP:	68	˚F	14.696 psia	CO_2=	61.46	kg/MMBtu	CO_2=	53.06	kg/MMBtu
Heat Content	1,444	Btu/scf (EPA)		CH_4=	0.003	kg/MMBtu	CH_4=	0.001	kg/MMBtu
Fuel HHV Correction Factor	1.416								

Heater Emission Calculations

Pollutants								
PM	7.6 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.016 Tons / Year**
SO_2	0.60 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.001 Tons / Year**
NO_X	100 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.215 Tons / Year**
CO	84 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.180 Tons / Year**
VOC	5.5 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.012 Tons / Year**
HAP	1.89 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.004 Tons / Year**
CO_2	0.5 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**256.18 Tons / Year**
N_2O	0.5 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.00048 Tons / Year**
CH_4	0.5 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.00483 Tons / Year**
Mass Sum	256.18 Tons / Year (CO_2)	+	0.0005 Tons / Year (N_2O)	+	0.0048 Tons / Year (CH_4)		=	**256.18 Tons / Year**
CO_2e	256.18 TPY X 1 = 256.18 (CO_2)	+	0.0005 TPY X 298 = 0.14 (N_2O)	+	0.0048 TPY X 25 = 0.12 (CH_4)		=	**256.44 Tons / Year**

[1] AP-42 emission factors taken from Chapter 1.4. Based on natural gas with 1020 btu/scf, and corrected in calculations. From Chapter 1.5, propane emission factors are equivalent on a heat basis to methane factors, except the NO_X factor is 1.5x higher.

Heater Treater 13-15

Data:				
H_2S mol%	0.00%	mol%		
Op Hours	8760	Hrs		
Heat Content	1,359	Btu/scf (Ind.)		
Flowrate	0.368	MScf/Hr (Ind.)		
Heat Input	500,000	Btu/hr		
Use btu/scf(EPA) for PM, NOx, CO, VOC. Factors for EPA STP (also ADEM STP). SO2 factor already for Industry STP (from Al. Oil & Gas Board)				
Ind. STP:	60	˚F	14.65	psia
EPA STP:	68	˚F	14.696	psia
Heat Content	1,342	Btu/scf (EPA)		
Fuel HHV Correction Factor	1.316			

AP-42 EF (NG)		
PM=	7.6	Lb/MMScf
NO_X=	100	Lb/MMScf
CO=	84	Lb/MMScf
VOC=	5.5	Lb/MMScf
HAP=	1.89	Lb/MMScf
SO_2=	0.60	Lb/MMScf

Based on NG with Btu/Content of 1020

GWP*	
N_2O=	298
CO_2=	1
CH_4=	25

*Revised 11/29/2013

(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_3			(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_1		
N_20=	0.0006	kg/MMBtu	N_20=	0.0001	kg/MMBtu
CO_2=	61.46	kg/MMBtu	CO_2=	53.06	kg/MMBtu
CH_4=	0.003	kg/MMBtu	CH_4=	0.001	kg/MMBtu

Heater Emission Calculations

Pollutants							
PM	7.6 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,342 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.316	= **0.016 Tons / Year**
SO_2	0.60 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,342 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.316	= **0.001 Tons / Year**
NO_X	100 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,342 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.316	= **0.215 Tons / Year**
CO	84 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,342 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.316	= **0.180 Tons / Year**
VOC	5.5 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,342 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.316	= **0.012 Tons / Year**
HAP	1.89 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,342 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.316	= **0.004 Tons / Year**
CO_2	0.5 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		= **256.18 Tons / Year**
N_2O	0.5 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		= **0.00048 Tons / Year**
CH_4	0.5 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		= **0.00483 Tons / Year**

Mass Sum	256.18 Tons / Year (**CO_2**)	+	0.0005 Tons / Year (**N_2O**)	+	0.0048 Tons / Year (**CH_4**)	=	**256.18 Tons / Year**
CO_2e	256.18 TPY X 1		0.0005 TPY X 298		0.0048 TPY X 25	=	**256.44 Tons / Year**
	256.18 (**CO_2**)	+	0.14 (**N_2O**)	+	0.12 (**CH_4**)		

[1] AP-42 emission factors taken from Chapter 1.4. Based on natural gas with 1020 btu/scf, and corrected in calculations. From Chapter 1.5, propane emission factors are equivalent on a heat basis to methane factors, except the NO_X factor is 1.5x higher.

Heater Treater 18-13

Data:				
H_2S mol%	0.00%	mol%		
Op Hours	8760	Hrs		
Heat Content	1,462	Btu/scf (Ind.)		
Flowrate	**0.342**	MScf/Hr (Ind.)		
Heat Input	500,000	Btu/hr		
Use btu/scf (EPA) for PM, NOx, CO, VOC. Factors for EPA STP (also ADEM STP). SO2 factor already for Industry STP (from Al. Oil & Gas Board)				
Ind. STP:	60	˚F	14.65	psia
EPA STP:	68	˚F	14.696	psia
Heat Content	1,444	Btu/scf (EPA)		
Fuel HHV Correction Factor	**1.416**			

AP-42 EF (NG)		
PM=	7.6	Lb/MMScf
NO_X=	100	Lb/MMScf
CO=	84	Lb/MMScf
VOC=	5.5	Lb/MMScf
HAP=	1.89	Lb/MMScf
SO_2=	0.60	Lb/MMScf

Based on NG with Btu/Content of 1020

GWP*	
N_2O=	298
CO_2=	1
CH_4=	25

*Revised 11/29/2013

(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_3		
N_2O=	0.0006	kg/MMBtu
CO_2=	61.46	kg/MMBtu
CH_4=	0.003	kg/MMBtu

(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_1		
N_2O=	0.0001	kg/MMBtu
CO_2=	53.06	kg/MMBtu
CH_4=	0.001	kg/MMBtu

Heater Emission Calculations

Pollutants								
PM	7.6 Lb	0.500 MMBtu	Scf (EPA)	8,760 Hr	1 Ton	1.416	=	**0.016 Tons**
	MMScf (EPA)	Hr	1,444 Btu	Year	2,000 Lb			**Year**
SO_2	0.60 Lb	0.500 MMBtu	Scf (EPA)	8,760 Hr	1 Ton	1.416	=	**0.001 Tons**
	MMScf (EPA)	Hr	1,444 Btu	Year	2,000 Lb			**Year**
NO_X	100 Lb	0.500 MMBtu	Scf (EPA)	8,760 Hr	1 Ton	1.416	=	**0.215 Tons**
	MMScf (EPA)	Hr	1,444 Btu	Year	2,000 Lb			**Year**
CO	84 Lb	0.500 MMBtu	Scf (EPA)	8,760 Hr	1 Ton	1.416	=	**0.180 Tons**
	MMScf (EPA)	Hr	1,444 Btu	Year	2,000 Lb			**Year**
VOC	5.5 Lb	0.500 MMBtu	Scf (EPA)	8,760 Hr	1 Ton	1.416	=	**0.012 Tons**
	MMScf (EPA)	Hr	1,444 Btu	Year	2,000 Lb			**Year**
HAP	1.89 Lb	0.500 MMBtu	Scf (EPA)	8,760 Hr	1 Ton	1.416	=	**0.004 Tons**
	MMScf (EPA)	Hr	1,444 Btu	Year	2,000 Lb			**Year**
CO_2	0.5 MMBtu	53.06 kg	0.001 Metric Ton	8,760 Hr	1.1023 Tons		=	**256.18 Tons**
	Hr	MMBtu	kg	Year	1 Metric Ton			**Year**
N_2O	0.5 MMBtu	0.0001 kg	0.001 Metric Ton	8,760 Hr	1.1023 Tons		=	**0.00048 Tons**
	Hr	MMBtu	kg	Year	1 Metric Ton			**Year**
CH_4	0.5 MMBtu	0.001 kg	0.001 Metric Ton	8,760 Hr	1.1023 Tons		=	**0.00483 Tons**
	Hr	MMBtu	kg	Year	1 Metric Ton			**Year**
Mass Sum	256.18 Tons	+	0.0005 Tons	+	0.0048 Tons		=	**256.18 Tons**
	Year		Year		Year			**Year**
	CO_2		**N_2O**		**CH_4**			
CO_2e	256.18 TPY X 1		0.0005 TPY X 298		0.0048 TPY X 25		=	**256.44 Tons**
	256.18	+	0.14	+	0.12			**Year**
	CO_2		**N_2O**		**CH_4**			

[1] AP-42 emission factors taken from Chapter 1.4. Based on natural gas with 1020 btu/scf, and corrected in calculations. From Chapter 1.5, propane emission factors are equivalent on a heat basis to methane factors, except the NO_X factor is 1.5x higher.

Heater Treater at 14-9

Data:				
H_2S mol%	0.00%	mol%		
Op Hours	8760	Hrs		
Heat Content	1,462	Btu/scf (Ind.)		
Flowrate	0.342	MScf/Hr (Ind.)		
Heat Input	500,000	Btu/hr		
Use btu/scf(EPA) for PM, NOx, CO, VOC. Factors for EPA STP (also ADEM STP). SO2 factor already for Industry STP (from Al. Oil & Gas Board)				
Ind. STP:	60	˚F	14.65	psia
EPA STP:	68	˚F	14.696	psia
Heat Content	1,444	Btu/scf (EPA)		
Fuel HHV Correction Factor	1.416			

AP-42 EF (NG)		
PM=	7.6	Lb/MMScf
NO_X=	100	Lb/MMScf
CO=	84	Lb/MMScf
VOC=	5.5	Lb/MMScf
HAP=	1.89	Lb/MMScf
SO_2=	0.60	Lb/MMScf

Based on NG with Btu/Content of 1020

GWP*	
N_2O=	298
CO_2=	1
CH_4=	25

*Revised 11/29/2013

(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_3		
N_2O=	0.0006	kg/MMBtu
CO_2=	61.46	kg/MMBtu
CH_4=	0.003	kg/MMBtu

(Table C-1 & C-2) 40 CFR Part 98 Sub C GHG Emission Factors for C_1		
N_2O=	0.0001	kg/MMBtu
CO_2=	53.06	kg/MMBtu
CH_4=	0.001	kg/MMBtu

Heater Emission Calculations

Pollutants								
PM	7.6 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.016 Tons / Year**
SO_2	0.60 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.001 Tons / Year**
NO_X	100 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.215 Tons / Year**
CO	84 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.180 Tons / Year**
VOC	5.5 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.012 Tons / Year**
HAP	1.89 Lb / MMScf (EPA)	0.500 MMBtu / Hr	Scf (EPA) / 1,444 Btu	8,760 Hr / Year	1 Ton / 2,000 Lb	1.416	=	**0.004 Tons / Year**
CO_2	0.5 MMBtu / Hr	53.06 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**256.18 Tons / Year**
N_2O	0.5 MMBtu / Hr	0.0001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.00048 Tons / Year**
CH_4	0.5 MMBtu / Hr	0.001 kg / MMBtu	0.001 Metric Ton / kg	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.00483 Tons / Year**
Mass Sum	256.18 Tons / Year (**CO_2**)	+	0.0005 Tons / Year (**N_2O**)	+	0.0048 Tons / Year (**CH_4**)		=	**256.18 Tons / Year**
CO_2e	256.18 TPY X 1 = 256.18 (**CO_2**)	+	0.0005 TPY X 298 = 0.14 (**N_2O**)	+	0.0048 TPY X 25 = 0.12 (**CH_4**)		=	**256.44 Tons / Year**

[1] AP-42 emission factors taken from Chapter 1.4. Based on natural gas with 1020 btu/scf, and corrected in calculations. From Chapter 1.5, propane emission factors are equivalent on a heat basis to methane factors, except the NO_X factor is 1.5x higher.

Flare at 24-1

Data	Total		Separator Gas		Tank Gas		~~Pilot Gas~~		GWP (11/29/2013)		40 CFR Part 98 Sub C GHG Emission Factors (Table C-1)		
Volume	**12,701.740**	scf/hr (Ind.)	300.0	Mscf/day	4.8	Mscf/day	~~0.0~~	~~Mscf/day~~	$N_2$0=	298			
H_2S mol%	0.0010%	mol%	0.0010%	mol%	0.0000%	mol%	~~0.0000%~~	~~mol%~~	CO_2=	1	$N_2$0=	0.0001	kg/MMBtu
Heat Content	1427.25	Btu/scf (Ind)	1416.00	Btu/scf (Ind)	2124.62	Btu/scf (Ind)	~~2500.00~~	~~Btu/scf (Ind)~~	CH_4=	25	AP 42 Emissions Factors[7]		
VOC MW	**10.75**	lb/lb-mol[2]	**10.49**	lb/lb-mol[2]	**26.76**	lb/lb-mol[2]	~~**43.24**~~	~~lb/lb-mol[2]~~			NO_X=	0.068	lb/MMBtu
CO_2	**0.81%**	mol%	**0.82%**	mol%	**0.18%**	mol%	~~**0.00%**~~	~~mol%~~			CO=	0.37	lb/MMBtu
CH_4	**61.80%**	mol%	**62.31%**	mol%	**30.03%**	mol%	~~**0.00%**~~	~~mol%~~			PM_1=	40	µg/L
C_6	**1.07**	lb/lb-mol[2]	**1.06**	lb/lb-mol[2]	**1.78**	lb/lb-mol[2]	~~**0.00**~~	~~lb/lb-mol[2]~~					
OP Hours	8760	Hrs							(Ind. STP)	scf/lbmol= 380.67	60	°F	14.65 psia
Destruction Eff	**98.00%**	DRE	Heat Input		**18.13**	MMBtu/hr[1]			(EPA STP)	scf/lbmol= 385.5	68	°F	14.696 psia

Potential Flare Emission Calculations

Pollutants																		
PM_1	40 µg / L	×	12701.7 scf (Ind.) / Hr	×	2.2E-9 lb / µg	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb	×	28.31685 L / scf (EPA)	×	1.01 scf(EPA) / 1 scf(Ind.)	=	**0.141 Tons / Year**			
SO_2	168.3 Lb SO_2[4] / MScf (Ind.)	×	12.702 MScf (Ind.) / Hr	×	0.001% H_2S Mol%	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb					=	**0.092 Tons / Year**			
NO_X	0.068 lb / MMBtu	×	18.129 MMBtu / Hr	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb							=	**5.399 Tons / Year**			
CO	0.37 lb / MMBtu	×	18.129 MMBtu / Hr	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb							=	**29.379 Tons / Year**			
VOC[5]	12,701.7 Scf (Ind.) / Hr	×	1 lb-mol / 380.67 scf (Ind.)	×	10.75 Lb VOC / Lb-Mole	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb	×	2.00% Inv. DRE			=	**31.422 Tons / Year**			
HAPs[8]	12,701.7 Scf (Ind.) / Hr	×	1 lb-mol / 380.67 scf (Ind.)	×	1.07 Lb C_6 / Lb-Mole	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb	×	2.00% Inv. DRE			=	**3.140 Tons / Year**			
CO_2[5,6] of Combustion	98.00% DRE	×	1.11E+08 Scf (Ind.) / Yr	×	1.61 lb-mol CO_2 (stoich.) / 1 lb-mol gas (stoich.)	×	1 lb-mol gas / 380.67 scf (Ind.)	×	44.01 lb CO_2 / lb-mole CO_2	×	1 Ton / 2,000 Lb	=	**10,132.14 Tons / Year**					
CO_2 of Fuel	1.11E+08 Scf (Ind.) / Yr	×	0.81% mol% CO_2	×	1 lb-mol / 380.67 scf (Ind.)	×	44.01 Lb CO2 / Lb-mole	×	1 Ton / 2,000 Lb	=	**52.09 Tons / Year**							
N_2O	0.001 M Ton / kg	×	0.001427 MMBtu / Scf (Ind.)	×	12,701.7 Scf (Ind.) / Hr	×	0.0001 kg / MMBtu	×	8,760 Hr / Year	×	1.1023 Tons / 1 Metric Ton	=	**0.0175 Tons / Year**					
CH_4 Uncombusted	1.11E+08 Scf (Ind.) / Yr	×	2.00% Inv. DRE	×	61.80% mol% CH_4	×	1 lb-mol / 380.675 scf (Ind.)	×	16.043 Lb CH4 / Lb-mole	×	1 Ton / 2,000 Lb	=	**28.98 Tons / Year**					
Mass Sum	10,184.23 Tons / Year CO2	+	0.0175 Tons / Year N2O	+	28.98 Tons / Year CH4	=	**10,213.22 Tons / Year**											
CO_2e	10,184.23 TPY / 10,184.23 CO2	X	1	+	0.0175 TPY / 5.22 N2O	X	298	+	28.98 TP / 724.46 CH4	X	25	=	**10,913.91 Tons / Year**					

[1] Rated Heat Capacity (MMBtu/Hr) = Flowrate (Scf/Hr) * Heat Content (Btu/Scf) * (MMBtu/10^6 Btu)

[2] VOC (Lb/Lb-mole) = Σ(Mole% of Each Compound)* (1%/100)*MW of Each Compound) -See Flare GHG Spreed Sheet for gas analysis

[3] Has to be maintained <500 lb/hr or 20 ppbv offsite concentration could potentially be exceeded

H_2S (Lb/hr) = Volume (Scf/hr) * (1 lb-mol/380.67) *(H_2S mol%) * (34.08 Lb H_2S/Lb-mol)

[4] SO_2 Conversion Factor 168.3 Lb SO_2/MScf of Gas

=(1,000 Scf/MScf) *(1Lb-Mole/380.67 Scf)* (64.066 Lb SO_2/Lb-Mole)

[5] Assuming the flare is 98% efficient

[6] Calculated using the gas analysis:

$\Sigma Y_j * R_j$ where, Y_j= mole fraction of gas hydrocarbon constituents' j (such as methane, ethane, propane, carbon dioxide, etc.) and R_j= number of carbon atoms in gas hydrocarbon constituent j: 1 for methane and carbon dioxide, 2 for ethane, 3 for propane, etc.

[7] Flare assumed to be "lightly smoking" in AP-42 table 13.5-1

[8] Hexane is a HAP. Assume Hexanes+ or Hexane are HAPS

Flare at 13-11

Data	Total		Separator Gas		Tank Gas		Pilot Gas	
Volume	**18,397.501**	scf/hr (Ind.)	435.0	Mscf/day	6.5	Mscf/day	~~0.0~~	~~Mscf/day~~
H_2S mol%	0.0004%	mol%	0.0004%	mol%	0.0000%	mol%	~~0.0000%~~	~~mol%~~
Heat Content	1471.91	Btu/scf (Ind)	1462.10	Btu/scf (Ind)	2124.62	Btu/scf (Ind)	~~1020.00~~	~~Btu/scf (Ind)~~
VOC MW	**11.79**	lb/lb-mol[2]	**11.57**	lb/lb-mol[2]	**26.76**	lb/lb-mol[2]	~~0.15~~	~~lb/lb-mol[2]~~
CO_2	**0.70%**	mol%	**0.71%**	mol%	**0.18%**	mol%	~~0.50%~~	~~mol%~~
CH_4	**60.58%**	mol%	**61.04%**	mol%	**30.03%**	mol%	~~95.00%~~	~~mol%~~
C_6	**1.40**	lb/lb-mol[2]	**1.39**	lb/lb-mol[2]	**1.78**	lb/lb-mol[2]	~~0.01~~	~~lb/lb-mol[2]~~
OP Hours	8760	Hrs						
Destruction Eff	**98.00%**	DRE	Heat Input		**27.08**	MMBtu/hr[1]		

GWP (11/29/2013)	
N_2O=	298
CO_2=	1
CH_4=	25

40 CFR Part 98 Sub C GHG Emission Factors (Table C-1)		
N_2O=	0.0001	kg/MMBtu
AP 42 Emissions Factors[7]		
NO_X=	0.068	lb/MMBtu
CO=	0.37	lb/MMBtu
PM_1=	40	µg/L

(Ind. STP)	scf/lbmol=	380.67	60	°F	14.65	psia
(EPA STP)	scf/lbmol=	385.5	68	°F	14.696	psia

Potential Flare Emission Calculations

Pollutants								=	Result
PM_1	40 µg / L	18397.5 scf (Ind.) / Hr	2.2E-9 lb / µg	8,760 Hr / Year	1 Ton / 2,000 Lb	28.31685 L / scf (EPA)	1.01 scf(EPA) / 1 scf(Ind.)	=	**0.204 Tons / Year**
SO_2	168.3 Lb SO_2[4] / MScf (Ind.)	18.398 MScf (Ind.) / Hr	0.000% H_2S Mol%	8,760 Hr / Year	1 Ton / 2,000 Lb			=	**0.053 Tons / Year**
NO_X	0.068 lb / MMBtu	27.080 MMBtu / Hr	8,760 Hr / Year	1 Ton / 2,000 Lb				=	**8.065 Tons / Year**
CO	0.37 lb / MMBtu	27.080 MMBtu / Hr	8,760 Hr / Year	1 Ton / 2,000 Lb				=	**43.885 Tons / Year**
VOC[5]	18,397.5 Scf (Ind.) / Hr	1 lb-mol / 380.67 scf (Ind.)	11.79 Lb VOC / Lb-Mole	8,760 Hr / Year	1 Ton / 2,000 Lb	2.00% Inv. DRE		=	**49.923 Tons / Year**
HAPs[8]	18,397.5 Scf (Ind.) / Hr	1 lb-mol / 380.67 scf (Ind.)	1.40 Lb C_6 / Lb-Mole	8,760 Hr / Year	1 Ton / 2,000 Lb	2.00% Inv. DRE		=	**5.910 Tons / Year**
CO_2[5,6] of Combustion	98.00% DRE	1.61E+08 Scf (Ind.) / Yr	1.66 lb-mol CO_2 (stoich.) / 1 lb-mol gas (stoich.)	1 lb-mol gas / 380.67 scf (Ind.)	44.01 lb CO_2 / lb-mole CO_2	1 Ton / 2,000 Lb		=	**15,182.98 Tons / Year**
CO_2 of Fuel	1.61E+08 Scf (Ind.) / Yr	0.70% mol% CO_2	1 lb-mol / 380.67 scf (Ind.)	44.01 Lb CO2 / Lb-mole	1 Ton / 2,000 Lb			=	**64.95 Tons / Year**
N_2O	0.001 M Ton / kg	0.001472 MMBtu / Scf (Ind.)	18,397.5 Scf (Ind.) / Hr	0.0001 kg / MMBtu	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	**0.0261 Tons / Year**
CH_4 Uncombusted	1.61E+08 Scf (Ind.) / Yr	2.00% Inv. DRE	60.58% mol% CH_4	1 lb-mol / 380.675 scf (Ind.)	16.043 Lb CH4 / Lb-mole	1 Ton / 2,000 Lb		=	**41.14 Tons / Year**
Mass Sum	15,247.93 Tons / Year (CO2)	+	0.0261 Tons / Year (N2O)	+	41.14 Tons / Year (CH4)			=	**15,289.10 Tons / Year**
CO_2e	15,247.93 TPY X 1 = 15,247.93 (CO2)	+	0.0261 TPY X 298 = 7.79 (N2O)	+	41.14 TP X 25 = 1,028.60 (CH4)			=	**16,284.32 Tons / Year**

[1] Rated Heat Capacity (MMBtu/Hr) = Flowrate (Scf/Hr) * Heat Content (Btu/Scf) * (MMBtu/10^6 Btu)

[2] VOC (Lb/Lb-mole) = Σ(Mole% of Each Compound)* (1%/100)*MW of Each Compound) -See Flare GHG Spreed Sheet for gas analysis

[3] Has to be maintained <500 lb/hr or 20 ppbv offsite concentration could potentially be exceeded

H_2S (Lb/hr) = Volume (Scf/hr) * (1 lb-mol/380.67) *(H_2S mol%) * (34.08 Lb H_2S/Lb-mol)

[4] SO_2 Conversion Factor 168.3 Lb SO_2/MScf of Gas

=(1,000 Scf/MScf) *(1Lb-Mole/380.67 Scf)* (64.066 Lb SO_2/Lb-Mole)

[5] Assuming the flare is 98% efficient

[6] Calculated using the gas analysis:

$\Sigma\, Y_j * R_j$ where, Y_j= mole fraction of gas hydrocarbon constituents' j (such as methane, ethane, propane, carbon dioxide, etc.) and R_j= number of carbon atoms in gas hydrocarbon constituent j: 1 for methane and carbon dioxide, 2 for ethane, 3 for propane, etc.

[7] Flare assumed to be "lightly smoking" in AP-42 table 13.5-1

[8] Hexane is a HAP. Assume Hexanes+ or Hexane are HAPS

Flare at 13-15

Data	Total		Separator Gas		Tank Gas		Pilot Gas	
Volume	13,780.828	scf/hr (Ind.)	325.0	Mscf/day	5.7	Mscf/day	~~0.0~~	~~Mscf/day~~
H_2S mol%	0.0004%	mol%	0.0005%	mol%	0.0000%	mol%	~~0.0000%~~	~~mol%~~
Heat Content	1372.19	Btu/scf (Ind)	1358.90	Btu/scf (Ind)	2124.62	Btu/scf (Ind)	~~1020.00~~	~~Btu/scf (Ind)~~
VOC MW	9.28	lb/lb-mol[2]	8.97	lb/lb-mol[2]	26.76	lb/lb-mol[2]	~~0.15~~	~~lb/lb-mol~~[2]
CO_2	0.76%	mol%	0.77%	mol%	0.18%	mol%	~~0.50%~~	~~mol%~~
CH_4	63.99%	mol%	64.59%	mol%	30.03%	mol%	~~95.00%~~	~~mol%~~
C_6	0.85	lb/lb-mol[2]	0.83	lb/lb-mol[2]	1.78	lb/lb-mol[2]	~~0.01~~	~~lb/lb-mol~~[2]
OP Hours	8760	Hrs						
Destruction Eff	98.00%	DRE	Heat Input		18.91	MMBtu/hr[1]		

GWP (11/29/2013)	
N_2O=	298
CO_2=	1
CH_4=	25

40 CFR Part 98 Sub C GHG Emission Factors (Table C-1)		
N_2O=	0.0001	kg/MMBtu
AP 42 Emissions Factors[7]		
NO_X=	0.068	lb/MMBtu
CO=	0.37	lb/MMBtu
PM_1=	40	µg/L

(Ind. STP)	scf/lbmol=	380.67	60	°F	14.65	psia
(EPA STP)	scf/lbmol=	385.5	68	°F	14.696	psia

Potential Flare Emission Calculations

Pollutants								=	
PM_1	40 µg / L	13780.8 scf (Ind.) / Hr	2.2E-9 lb / µg	8,760 Hr / Year	1 Ton / 2,000 Lb	28.31685 L / scf (EPA)	1.01 scf(EPA) / 1 scf(Ind.)	=	0.153 Tons / Year
SO_2	168.3 Lb SO_2[4] / MScf (Ind.)	13.781 MScf (Ind.) / Hr	0.000% H_2S Mol%	8,760 Hr / Year	1 Ton / 2,000 Lb			=	0.045 Tons / Year
NO_X	0.068 lb / MMBtu	18.910 MMBtu / Hr	8,760 Hr / Year	1 Ton / 2,000 Lb				=	5.632 Tons / Year
CO	0.37 lb / MMBtu	18.910 MMBtu / Hr	8,760 Hr / Year	1 Ton / 2,000 Lb				=	30.645 Tons / Year
VOC[5]	13,780.8 Scf (Ind.) / Hr	1 lb-mol / 380.67 scf (Ind.)	9.28 Lb VOC / Lb-Mole	8,760 Hr / Year	1 Ton / 2,000 Lb	2.00% Inv. DRE		=	29.424 Tons / Year
HAPs[8]	13,780.8 Scf (Ind.) / Hr	1 lb-mol / 380.67 scf (Ind.)	0.85 Lb C_6 / Lb-Mole	8,760 Hr / Year	1 Ton / 2,000 Lb	2.00% Inv. DRE		=	2.689 Tons / Year
CO_2[5,6] of Combustion	98.00% DRE	1.21E+08 Scf (Ind.) / Yr	1.53 lb-mol CO_2 (stoich.) / 1 lb-mol gas (stoich.)	1 lb-mol gas / 380.67 scf (Ind.)	44.01 lb CO_2 / lb-mole CO_2	1 Ton / 2,000 Lb		=	10,491.28 Tons / Year
CO_2 of Fuel	1.21E+08 Scf (Ind.) / Yr	0.76% mol% CO_2	1 lb-mol / 380.67 scf (Ind.)	44.01 Lb CO2 / Lb-mole	1 Ton / 2,000 Lb			=	52.81 Tons / Year
N_2O	0.001 M Ton / kg	0.001372 MMBtu / Scf (Ind.)	13,780.8 Scf (Ind.) / Hr	0.0001 kg / MMBtu	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton		=	0.0183 Tons / Year
CH_4 Uncombusted	1.21E+08 Scf (Ind.) / Yr	2.00% Inv. DRE	63.99% mol% CH_4	1 lb-mol / 380.675 scf (Ind.)	16.043 Lb CH4 / Lb-mole	1 Ton / 2,000 Lb		=	32.56 Tons / Year
Mass Sum	10,544.09 Tons / Year CO2	+	0.0183 Tons / Year N2O	+	32.56 Tons / Year CH4			=	10,576.66 Tons / Year
CO_2e	10,544.09 TPY X 1 = 10,544.09 CO2	+	0.0183 TPY X 298 = 5.44 N2O	+	32.56 TP X 25 = 813.89 CH4			=	11,363.42 Tons / Year

[1] Rated Heat Capacity (MMBtu/Hr) = Flowrate (Scf/Hr) * Heat Content (Btu/Scf) * (MMBtu/10^6 Btu)

[2] VOC (Lb/Lb-mole) = Σ(Mole% of Each Compound)* (1%/100)*MW of Each Compound) -See Flare GHG Spreed Sheet for gas analysis

[3] Has to be maintained <500 lb/hr or 20 ppbv offsite concentration could potentially be exceeded

H_2S (Lb/hr) = Volume (Scf/hr) * (1 lb-mol/380.67) *(H_2S mol%) * (34.08 Lb H_2S/Lb-mol)

[4] SO_2 Conversion Factor 168.3 Lb SO_2/MScf of Gas

=(1,000 Scf/MScf) *(1Lb-Mole/380.67 Scf)* (64.066 Lb SO_2/Lb-Mole)

[5] Assuming the flare is 98% efficient

[6] Calculated using the gas analysis:

$\Sigma Y_j * R_j$ where, Y_j= mole fraction of gas hydrocarbon constituents' j (such as methane, ethane, propane, carbon dioxide, etc.) and R_j= number of carbon atoms in gas hydrocarbon constituent j: 1 for methane and carbon dioxide, 2 for ethane, 3 for propane, etc.

[7] Flare assumed to be "lightly smoking" in AP-42 table 13.5-1

[8] Hexane is a HAP. Assume Hexanes+ or Hexane are HAPS

Flare 18-13

Data	Total		Separator Gas		Tank Gas		~~Pilot Gas~~	
Volume	**12,660.867**	scf/hr (Ind.)	300.0	Mscf/day	3.9	Mscf/day	~~0.0~~	~~Mscf/day~~
H_2S mol%	0.0006%	mol%	0.0006%	mol%	0.0000%	mol%	~~0.0000%~~	~~mol%~~
Heat Content	1421.38	Btu/scf (Ind)	1412.33	Btu/scf (Ind)	2124.62	Btu/scf (Ind)	~~1020.00~~	~~Btu/scf (Ind)~~
VOC MW	**10.55**	lb/lb-mol[2]	**10.34**	lb/lb-mol[2]	**26.76**	lb/lb-mol[2]	~~0.15~~	~~lb/lb-mol[2]~~
CO_2	**0.76%**	mol%	**0.76%**	mol%	**0.18%**	mol%	~~0.50%~~	~~mol%~~
CH_4	**62.23%**	mol%	**62.65%**	mol%	**30.03%**	mol%	~~95.00%~~	~~mol%~~
C_6	**1.10**	lb/lb-mol[2]	**1.09**	lb/lb-mol[2]	**1.78**	lb/lb-mol[2]	~~0.01~~	~~lb/lb-mol[2]~~
OP Hours	8760	Hrs						
Destruction Eff	**98.00%**	DRE	Heat Input		**18.00**	MMBtu/hr[1]		

GWP (11/29/2013)	
N_20=	298
CO_2=	1
CH_4=	25

40 CFR Part 98 Sub C GHG Emission Factors (Table C-1)		
N_20=	0.0001	kg/MMBtu

AP 42 Emissions Factors[7]		
NO_X=	0.068	lb/MMBtu
CO=	0.37	lb/MMBtu
PM_1=	40	µg/L

(Ind. STP)	scf/lbmol=	380.67	60	°F	14.65	psia
(EPA STP)	scf/lbmol=	385.5	68	°F	14.696	psia

Potential Flare Emission Calculations

Pollutants

PM_1	40 µg / L	×	12660.9 scf (Ind.) / Hr	×	2.2E-9 lb / µg	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb	28.31685 L / scf (EPA)	×	1.01 scf(EPA) / 1 scf(Ind.)	=	**0.140 Tons / Year**
SO_2	168.3 Lb SO_2[4] / MScf (Ind.)	×	12.661 MScf (Ind.) / Hr	×	0.001% H_2S Mol%	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb				=	**0.057 Tons / Year**
NO_X	0.068 lb / MMBtu	×	17.996 MMBtu / Hr	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb						=	**5.360 Tons / Year**
CO	0.37 lb / MMBtu	×	17.996 MMBtu / Hr	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb						=	**29.164 Tons / Year**
VOC[5]	12,660.9 Scf (Ind.) / Hr	×	1 lb-mol / 380.67 scf (Ind.)	×	10.55 Lb VOC / Lb-Mole	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb	2.00% Inv. DRE			=	**30.742 Tons / Year**
HAPs[8]	12,660.9 Scf (Ind.) / Hr	×	1 lb-mol / 380.67 scf (Ind.)	×	1.10 Lb C_6 / Lb-Mole	×	8,760 Hr / Year	×	1 Ton / 2,000 Lb	2.00% Inv. DRE			=	**3.215 Tons / Year**
CO_2[5,6] of Combustion	98.00% DRE	×	1.11E+08 Scf (Ind.) / Yr	×	1.60 lb-mol CO_2 (stoich.) / 1 lb-mol gas (stoich.)	×	1 lb-mol gas / 380.67 scf (Ind.)	×	44.01 lb CO_2 / lb-mole CO_2	1 Ton / 2,000 Lb			=	**10,042.79 Tons / Year**
CO_2 of Fuel	1.11E+08 Scf (Ind.) / Yr	×	0.76% mol% CO_2	×	1 lb-mol / 380.67 scf (Ind.)	×	44.01 Lb CO2 / Lb-mole	×	1 Ton / 2,000 Lb				=	**48.50 Tons / Year**
N_2O	0.001 M Ton / kg	×	0.001421 MMBtu / Scf (Ind.)	×	12,660.9 Scf (Ind.) / Hr	×	0.0001 kg / MMBtu	×	8,760 Hr / Year	1.1023 Tons / 1 Metric Ton			=	**0.0174 Tons / Year**
CH_4 Uncombusted	1.11E+08 Scf (Ind.) / Yr	×	2.00% Inv. DRE	×	62.23% mol% CH_4	×	1 lb-mol / 380.675 scf (Ind.)	×	16.043 Lb CH4 / Lb-mole	1 Ton / 2,000 Lb			=	**29.09 Tons / Year**
Mass Sum	10,091.29 Tons / Year (CO2)	+	0.0174 Tons / Year (N2O)	+	29.09 Tons / Year (CH4)								=	**10,120.40 Tons / Year**
CO_2e	10,091.29 TPY (10,091.29 CO2)	× 1 +	0.0174 TPY (5.18 N2O)	× 298 +	29.09 TP (727.19 CH4)	× 25							=	**10,823.66 Tons / Year**

[1] Rated Heat Capacity (MMBtu/Hr) = Flowrate (Scf/Hr) * Heat Content (Btu/Scf) * (MMBtu/10^6 Btu)

[2] VOC (Lb/Lb-mole) = Σ(Mole% of Each Compound)* (1%/100)*MW of Each Compound) -See Flare GHG Spreed Sheet for gas analysis

[3] Has to be maintained <500 lb/hr or 20 ppbv offsite concentration could potentially be exceeded

H_2S (Lb/hr) = Volume (Scf/hr) * (1 lb-mol/380.67) *(H_2S mol%) * (34.08 Lb H_2S/Lb-mol)

[4] SO_2 Conversion Factor 168.3 Lb SO_2/MScf of Gas

=(1,000 Scf/MScf) *(1Lb-Mole/380.67 Scf)* (64.066 Lb SO_2/Lb-Mole)

[5] Assuming the flare is 98% efficient

[6] Calculated using the gas analysis:

$\Sigma Y_j * R_j$ where, Y_j= mole fraction of gas hydrocarbon constituents' j (such as methane, ethane, propane, carbon dioxide, etc.) and R_j= number of carbon atoms in gas hydrocarbon constituent j: 1 for methane and carbon dioxide, 2 for ethane, 3 for propane, etc.

[7] Flare assumed to be "lightly smoking" in AP-42 table 13.5-1

[8] Hexane is a HAP. Assume Hexanes+ or Hexane are HAPS

Flare at 14-9

Data	Total		Separator Gas		Tank Gas		~~Pilot Gas~~	
Volume	**12,660.867**	scf/hr (Ind.)	300.0	Mscf/day	3.9	Mscf/day	~~0.0~~	~~Mscf/day~~
H_2S mol%	0.0006%	mol%	0.0006%	mol%	0.0000%	mol%	~~0.0000%~~	~~mol%~~
Heat Content	1421.38	Btu/scf (Ind)	1412.33	Btu/scf (Ind)	2124.62	Btu/scf (Ind)	~~1020.00~~	~~Btu/scf (Ind)~~
VOC MW	**10.55**	lb/lb-mol[2]	**10.34**	lb/lb-mol[2]	**26.76**	lb/lb-mol[2]	~~0.15~~	~~lb/lb-mol[2]~~
CO_2	**0.76%**	mol%	**0.76%**	mol%	**0.18%**	mol%	~~0.50%~~	~~mol%~~
CH_4	**62.23%**	mol%	**62.65%**	mol%	**30.03%**	mol%	~~95.00%~~	~~mol%~~
C_6	**1.10**	lb/lb-mol[2]	**1.09**	lb/lb-mol[2]	**1.78**	lb/lb-mol[2]	~~0.01~~	~~lb/lb-mol[2]~~
OP Hours	8760	Hrs						
Destruction Eff	**98.00%**	DRE	Heat Input		**18.00**	MMBtu/hr[1]		

GWP (11/29/2013)	
N_20=	298
CO_2=	1
CH_4=	25

40 CFR Part 98 Sub C GHG Emission Factors (Table C-1)		
N_20=	0.0001	kg/MMBtu

AP 42 Emissions Factors[7]		
NO_X=	0.068	lb/MMBtu
CO=	0.37	lb/MMBtu
PM_1=	40	µg/L

(Ind. STP)	scf/lbmol=	380.67	60	°F	14.65	psia
(EPA STP)	scf/lbmol=	385.5	68	°F	14.696	psia

Potential Flare Emission Calculations

Pollutants

PM_1	40	µg	12660.9	scf (Ind.)	2.2E-9	lb	8,760	Hr	1	Ton	28.31685	L	1.01	scf(EPA)	=	**0.140**	**Tons**
	L		Hr		µg		Year		2,000	Lb	scf (EPA)		1	scf(Ind.)		**Year**	
SO_2	168.3	Lb SO_2[4]	12.661	MScf (Ind.)	0.001%	H_2S Mol%	8,760	Hr	1	Ton					=	**0.057**	**Tons**
	MScf (Ind.)		Hr				Year		2,000	Lb						**Year**	
NO_X	0.068	lb	17.996	MMBtu	8,760	Hr	1	Ton							=	**5.360**	**Tons**
	MMBtu		Hr		Year		2,000	Lb								**Year**	
CO	0.37	lb	17.996	MMBtu	8,760	Hr	1	Ton							=	**29.164**	**Tons**
	MMBtu		Hr		Year		2,000	Lb								**Year**	
VOC[5]	12,660.9	Scf (Ind.)	1	lb-mol	10.55	Lb VOC	8,760	Hr	1	Ton	2.00%	Inv. DRE			=	**30.742**	**Tons**
	Hr		380.67	scf (Ind.)	Lb-Mole		Year		2,000	Lb						**Year**	
HAPs[8]	12,660.9	Scf (Ind.)	1	lb-mol	1.10	Lb C_6	8,760	Hr	1	Ton	2.00%	Inv. DRE			=	**3.215**	**Tons**
	Hr		380.67	scf (Ind.)	Lb-Mole		Year		2,000	Lb						**Year**	
CO_2[5,6] of Combustion	98.00%	DRE	1.11E+08	Scf (Ind.)	1.60	lb-mol CO_2 (stoich.)	1	lb-mol gas	44.01	lb CO_2	1 Ton				=	**10,042.79**	**Tons**
			Yr		1	lb-mol gas (stoich.)	380.67	scf (Ind.)	lb-mole CO_2		2,000 Lb					**Year**	
CO_2 of Fuel	1.11E+08	Scf (Ind.)	0.76%	mol% CO_2	1	lb-mol	44.01	Lb CO2	1 Ton						=	**48.50**	**Tons**
	Yr				380.67	scf (Ind.)	Lb-mole		2,000 Lb							**Year**	
N_2O	0.001	M Ton	0.001421	MMBtu	12,660.9	Scf (Ind.)	0.0001	kg	8,760	Hr	1.1023	Tons			=	**0.0174**	**Tons**
	kg		Scf (Ind.)		Hr		MMBtu		Year		1 Metric Ton					**Year**	
CH_4 Uncombusted	1.11E+08	Scf (Ind.)	2.00%	Inv. DRE	62.23%	mol% CH_4	1	lb-mol	16.043	Lb CH4	1 Ton				=	**29.09**	**Tons**
	Yr						380.675	scf (Ind.)	Lb-mole		2,000 Lb					**Year**	
Mass Sum	10,091.29	Tons	+		0.0174	Tons	+		29.09	Tons					=	**10,120.40**	**Tons**
	Year				Year				Year							**Year**	
	CO2				N2O				CH4								
CO_2e	10,091.29	TPY	X 1		0.0174	TPY	X 298		29.09	TP	X 25				=	**10,823.66**	**Tons**
	10,091.29		+		5.18		+		727.19							**Year**	
	CO2				N2O				CH4								

[1] Rated Heat Capacity (MMBtu/Hr) = Flowrate (Scf/Hr) * Heat Content (Btu/Scf) * (MMBtu/10^6 Btu)

[2] VOC (Lb/Lb-mole) = Σ(Mole% of Each Compound)* (1%/100)*MW of Each Compound) -See Flare GHG Spreed Sheet for gas analysis

[3] Has to be maintained <500 lb/hr or 20 ppbv offsite concentration could potentially be exceeded

H_2S (Lb/hr) = Volume (Scf/hr) * (1 lb-mol/380.67) *(H_2S mol%) * (34.08 Lb H_2S/Lb-mol)

[4] SO_2 Conversion Factor 168.3 Lb SO_2/MScf of Gas

=(1,000 Scf/MScf) *(1Lb-Mole/380.67 Scf)* (64.066 Lb SO_2/Lb-Mole)

[5] Assuming the flare is 98% efficient

[6] Calculated using the gas analysis:

$\Sigma Y_j * R_j$ where, Y_j= mole fraction of gas hydrocarbon constituents' j (such as methane, ethane, propane, carbon dioxide, etc.) and R_j= number of carbon atoms in gas hydrocarbon constituent j: 1 for methane and carbon dioxide, 2 for ethane, 3 for propane, etc.

[7] Flare assumed to be "lightly smoking" in AP-42 table 13.5-1

[8] Hexane is a HAP. Assume Hexanes+ or Hexane are HAPS